THURSDAY, JULY 4, 1878

THE EPOCH OF THE MAMMOTH

The Epoch of the Mammoth. By G. James C. Southwell, A.M., LL.D. 8vo. (London: Trübner, 1878.)

BOOKS may be divided into three classes from the point of view offered by criticism, and apart from all considerations of style. There are carefully-written books, the natural fruit of much thought and labour by men who have special knowledge of their subject and who spare no pains to avoid using faulty materials which afterwards may have to be removed, as is generally the case, with much trouble and annoyance. The second class consists of books written without care and very generally the outcome of ignorance or vanity, full of errors, and worse than useless; and lastly, there are some books containing much useful information, but so grouped around views which are utterly wrong that they are worthless for any purpose in which exact knowledge is required. In this class very generally the true is so mingled with the false that it requires the eye of an expert to tell the one from the other. With the first and second of these classes it is easy for a reviewer to deal. It is his duty to welcome the first, not without pointing out (if he can, and we know from experience that very frequently he cannot) the mistakes inseparable from all books, just as he is bound to rebuke sternly the second, and to warn the reader that he is on dangerous ground. It is, however, hard to do justice to the third; for while the information may be useful *per se*, in its position in the book it may be mischievous because it is worked into a wrong hypothesis, thus fulfilling Lord Palmerston's definition of dirt as "matter in the wrong place."

The work before us falls into the third class. Its author seems to have skimmed most of the current literature of the day, more especially reviews, and out of the vast array of facts at his command has picked out those suitable to his views on the recent origin of man. Many of his facts are true, but they are so grouped as to lead the reader to a wrong conclusion. Many of his asserted facts are untrue. The work is a sequel to "The Recent Origin of Man," reviewed in this journal, and is to a large extent an answer to the criticism which it then provoked. We regret that the author has not profited by his experience and that he should have expended so much trouble in attempting to prove a negative which in the nature of things cannot be proved.

The author's aim is to show that man has not appeared on the earth more than six or ten thousand years. He starts from the historical basis offered by the Bible, and in support of chronology ingrafted on the Holy Writ by the unfortunate ingenuity of Archbishop Usher, and in defence of the high civilisation of primeval man, he seizes some of the scraps of history flung out in the struggle between various Babylonian and Egyptian scholars. He adds to these his own views of the discoveries at Hissarlik and Mycæne, and the recent results of exploration in Etruscan tombs and dwellings in Italy, ultimately arriving at the conclusion that man is not older in the Mediterranean area than ten thousand years. To all this the obvious answer suggests itself, that history can tell us nothing as to the antiquity of the human race, because written characters, essential to history, are the result of a high civilisation. How long it took mankind to work out through picture writing a record of the past is an idle question, since we have no data bearing on the point; but we cannot believe that the art of writing was elaborated in a short time. "Fortes vixere ante Agamemnona" whose names we know not.

To attempt to circumscribe the antiquity of man within the limits of history appears to us as idle and barren an attempt as could possibly be undertaken. It would be as reasonable to seek figs growing on thistles as to look for any proof of the recent origin of man in the written record. These facts are so obvious in the present condition of knowledge, that we should not bring them before our readers were they not utterly ignored by the author of this work, as well as by some of his critics.

Our author having established to his own satisfaction the recent origin of man in the Mediterranean countries, enters into the question of the unity of the human race. The pre-Christian cross, either in the form of the handle cross of the Mediterranean districts or the Swastika of the Buddhists, was widely spread among ancient peoples. The tradition of a deluge is almost universal. That of a terrestrial paradise is widely spread: we read of the gardens of Alcinous and Laertes, of the Asgard of the Scandinavians, and of sundry other gardens mentioned in various writers Indian, Chinese, and Arabian. Then we have Megalithic monuments scattered over widely-separated countries, and the habit of distorting the human skull, and of scalping. The range, also, of the boomerang, pointed out by Gen. Lane Fox, the custom of depositing flint implements in graves, and of worshipping phalli and serpents, are taken to "prove the unity of the race, almost without any other argument on the subject."

Then the author proceeds to his application, "If the human race is one, the Egyptian, the Hindoo, the Babylonian, and the palæolithic tribes of the Somme Valley were one; and if Kephren and Cheops were near of kin to the fossil man of Mentone or the savage who owned the Neanderthal skull, and if, moreover, the antiquity of man in Babylonia does not go farther back than some ten thousand years, *then* the men of the French and English river gravels cannot be more than ten thousand years old. The reverse would only be possible on the hypothesis that the Egyptians were the descendants of the men of the Somme Valley. But this is excluded by the fact that the Egyptians appear at once as a civilised race; and, as we have stated, there are no earlier remains of any kind in Egypt" (p. 21). We give this as an example of the style of reasoning. So far as we know, nobody, not even the author, has ventured to assert that the two Egyptian kings above mentioned "were near of kin" to the so-called fossil man of Mentone, or stood in any near relationship to any of the ancient inhabitants of Europe. The argument is to us wholly unintelligible. Why should the Egyptians be descended from the men of the Somme Valley any

more than the latter from the Egyptians? The civilisation of Egypt throws about as much light upon the barbarism of the palæolithic age as that does upon the civilisation of Egypt.

The author has taken great pains to break down the archæological classification by the trite argument that bronze, iron, and stone have been very frequently found together in various parts of Europe. We suppose that no modern archæologist has disputed the fact. Dr. John Evans holds that they shade off into one another like the prismatic colours of a rainbow, Dr. Keller and Mr. Lee, his able translator, give numerous examples from the pile dwellings of Switzerland, and other places, of the association of implements composed of these materials. This association, however, has nothing to do with the question as to whether the archæological classification is correct. The conclusion of the Scandinavian and Swiss archæologists, that the use of stone, bronze, and iron characterises three distinct phases in the civilisation of mankind in Europe, has been amply confirmed by the numerous discoveries made during the last five-and-twenty years. They are merely the outward marks of new stages of culture.

Nor has the subdivision of the stone age into palæolithic and neolithic, by Sir John Lubbock, been shaken; they are separated from one another by the greatest changes in climate and geography, and in animal life, which have taken place since the arrival of man in Europe. Our author, however, denies this, and brings forward a series of examples derived, for the most part, from accounts either unverified by subsequent observers or in themselves equivocal, to show that the palæolithic men possessed domestic horses, oxen, pigs, dogs, and "hens," and were acquainted with the art of making pottery. We have no space to examine each of these statements in detail. We would merely say that the scientific exploration of caverns and tombs is by no means easy, and that until comparatively recently everything of unknown date found in them was supposed to belong to about the same age. Hence it is that the literature of archæology offers to the author the examples which he gives us.

With regard to pottery it must be remarked that the vessels assigned to a palæolithic age, such as that of the Trou de Frontal, belong to well-known neolithic types, and that the domestic animals assigned to the same age are identical with those of the neolithic farmers and herdsmen. Caves were used by the neolithic peoples for purposes of habitation and burial. The duty, therefore, of proving that these things are of palæolithic age rests with the author;—it is not the business of a reviewer to undertake proof of a negative that they are not. The assertion, however, that no neolithic implements have been met with in the same cave as the so-called "fossil man of Mentone," whom we have always believed to belong to that age, is negatived by the polished celt from that cave which we have seen in the museum at St. Germains—an important fact, which, strangely enough, has escaped the notice of all who have hitherto written on the subject.

We shall not repeat the arguments in favour of the palæolithic age of the interments at Solutré, which have already been combated in this review. We have always held that they are not earlier than Gallo-Roman times. The results of the further researches of MM. Ducrost and Arcelin, in 1875-6, show that, above the strata containing the remains of mammoth, reindeer, horses, and palæolithic implements, there is a stratum containing polished stone axes, iron and bronze implements, and interments of the neolithic, Gallo-Roman Burgundian times. The so-called palæolithic are in all probability referable to one of these three ages, and from the fact of the skeletons resting at full length to one or other of the two last periods.

The author is not content with bridging over the interval between the neolithic and palæolithic times by the asserted occurrence in the latter of characteristics hitherto to be considered peculiar to the former. He tells us that extinct pleistocene animals lived "some of them down to historic and even post-Roman times." In support of this view he brings forward the occurrence of the mammoth from the peat bogs of Holyhead, Torquay, and Colchester, just as if there were no peat bogs in the pleistocene times—as, for example, the pre-glacial forest-bed, with mammoth and other creatures, on the shores of Norfolk and Suffolk. He relies also upon the fresh condition of the carcases of the Siberian mammoth as evidence against high antiquity, just as if ice would not preserve anything imbedded in it for an indefinite length of time.

Palæontologists will be astonished to hear that the cave-bear has been met with in the peat bogs of Denmark, and in Italy in association with relics of the neolithic age. The first of these reputed occurrences has been given up by M. Nilsson, and the second has not been verified by any competent authority. The latter observation will also hold good regarding the reputed occurrence of the cave lion in the peat of Holderness. The Irish elk is asserted by our author to have been living in the marshes of Europe as late as the fourteenth century, a statement based on a speculation of Brandt's that the Machlis of Pliny and the Schelch of the *Niebelungen Lied* are identical with that animal. The palæolithic implements themselves (p. 220) are traced to the stone axe from Babylon, preserved in the British Museum, of a "palæolithic type which reappeared in Europe when some of the ruder Turanian tribes migrated in that direction."

It is not profitable to pursue this review further, for in this work one printed statement is treated as if it were of equal value with another, without any attempt being made to sift the improbable from the probable, or the true from the false. The facts are brought together in it very much like flies—if one may indulge in a comparison—on a fly-paper, and bear the same relation to each other as the heterogeneous collection of dead and dying winged creatures there brought together in a strange fellowship. We regret that the writer should have spent so much time as he evidently has spent in collecting matter for a book written without scientific method, and which certainly does not prove that the age of the mammoth is removed from the present time by an interval of from six to ten thousand years.

W. B. D.

RECENT MATHEMATICAL WORKS

An Elementary Treatise on the Dynamics of a System of Rigid Bodies, with Numerous Examples. By E. J. Routh, M.A., F.R.S., F.R.A.S., F.G.S. Third Edition, Revised and Enlarged. 8vo, pp. 564, xii. (London: Macmillan and Co., 1877.)

A Treatise on Statics, containing some of the Fundamental Propositions in Electro-Statics. By G. M. Minchin, M.A. 8vo, pp. 450, xii. (Longmans, 1877.)

Lectures on the Elements of Applied Mechanics, comprising (1) *Stability of Structures;* (2) *Strength of Materials.* By M. W. Crofton, F.R.S. Printed for the Use of the Royal Military Academy. Pp. 107. (C. F. Hodgson and Son, 1877.)

Handbook of Natural Philosophy—Mechanics. By D. Lardner, D.C.L. New Edition, Edited and considerably Enlarged, by B. Loewy, F.R.A.S. Pp. 489, xxii. (Crosby Lockwood and Co., 1877.)

The Book of Mechanics. Part I.—Statics. By R. Oscar Thorpe, M.A. (Stewart's Local Examination Series, 1877.)

THE main features of Mr. Routh's admirable treatise are well known to students. The first edition, of 336 pages, appeared in 1860; the second, of 492 pages, in 1868; the present consists of 564 pages, each page containing from a third to a half as much matter more than the page of the earlier editions. Some idea may thus be formed of the great amount of new matter. Of this increase take another proof: in the second edition the chapter on *Small Oscillations* took up pp. 273 to 322; in this edition the subject occupies pp. 325 to 403! The author assigns as a reason for this increase, "I have been led" to make these additions "because there are so many important applications which it did not seem proper to pass over without some notice."

An interesting feature is the increased number of historical notices, though these are confessedly very slight, drawn from Montucla (by a misprint Montuela), Prof. Cayley's Report on Theoretical Dynamics (British Association Report, vol. xxvi.), and other sources. Some of these are relegated to an appendix. A great number of original memoirs have been consulted and some of these of very recent date. We do not notice in Articles 282, 475, in which a discussion of the problem of Laplace's three particles is given, any reference to the author's paper on the subject in the *Proceedings* of the London Mathematical Society (vol. vi. No. 81, pp. 86-97), though of course the substance of this paper is given in the text. We note this, because in both places Mr. Routh cites a reference, by M. Jullien, to a Thèse de Mécanique, by M. Gascheau, which he has not succeeded in verifying. Perhaps a notice of this point in NATURE may lead to the matter being cleared up for Mr. Routh's satisfaction. We have not ourselves met with this pamphlet by M. Gascheau. We could dwell much longer on this fine work, pointing out the numerous places where new proofs are given and entirely new matter is introduced, but we need only say that it must claim a very high place in our mathematical literature, and go far to remove the reproach brought against Cambridge text-books by students who have become familiar with the works of continental mathematicians. There is an ample and diversified collection of problems which are given in the several chapters and appended to them. Following a common practice, the author gives a list of articles to which beginners should first turn their attention.

Prof. Minchin purposely omits the prefix "Elementary," his main object being to give "a tolerably comprehensive view of statics." Very early in his book he introduces the conception of "virtual work," a term he adopts from the best French writers (Collignon, Delaunay, and others) in preference to "virtual velocities." His reason for bringing the subject so soon before the student is "the conception of work is the most prominent in modern physics, and, therefore, at the risk of being charged with prolixity, I have shown in the earliest chapters how all the conditions of equilibrium of a system may be obtained from the principle of virtual work independently of the usual mode of the reduction of forces." Graphic methods are used in the earlier portions; a good feature, now that the treatises of Culmann, Bauschinger, and Cremona are in the hands of many English students. The subjects treated of are much the same as in other treatises in our hands, and the last chapter (pp. 403 to 450) is devoted to the theory of the potential; the modes of treatment, however, are different.

Prof. Minchin attaches great importance to the solution of problems, and so takes care to solve a great many leading cases, and has done good service to students by these solutions and by the figures which he gives. The following remarks speak for themselves:—"It is characteristic of the system of 'cramming,' which has been called into existence by modern competitive examinations, that the *applications* of mathematics, as exhibited in the solution of examples, are greatly neglected. A cause contributing to this objectionable system appears to me to exist in our mathematical treatises, many of which are almost wholly filled with unsolved problems and dry 'book-work,' which the student never learns to apply. I have therefore very largely illustrated the principles of the subject by solved examples, and I have attached at least as much importance to examples, all through, as to the abstract principles which they illustrate."

We cordially commend the book, and hold that it is no unworthy companion of such text-books as those of Dr. Salmon and of Mr. Williamson.

Prof. Crofton's book is a "Synopsis of a Course of Lectures on the Elements of the Theory of Structures and the Strength of Materials, forming the First Part of the Course of Applied Mechanics at present studied by the Gentlemen Cadets of the Royal Military Academy." The book requires to be read with some care, as the author's idea is that it should be supplemented by *viva voce* instruction and by experimental illustrations. It is thoroughly elementary, however, and avoids all aid from the differential and integral calculus. Great importance has been deservedly attached to the elegant method of diagrams of forces and to Culmann's graphical method. In the first part are considered such matters as frames, roofs, trussed beams, chains, and cords, and the stability of walls. In the second part come under notice resistance to stretching and to compression, theory of beams, moment of resistance in rectangular beams, girders, open girders, partially loaded beams, and other thoroughly practical matters. Prof. Crofton has wisely given a great

number of figures, and in addition to numerous unsolved exercises, has given very many worked-out problems. In his introduction he points out that "the practical man, unlike the theoretical, cannot choose his problems; he must take those which the requirements of his art present, whether elegant and curious, or cumbrous and repulsive. Moreover, in his case, *some* solution of every problem must be obtained; if he is unable to find a rigorous scientific solution he must make some further assumptions or have recourse to experiment; he cannot lay the question aside." He goes on further to point out the differences between the two studies of theoretical and applied mechanics. The author has brought the subject before the notice of mathematicians in communications to the Mathematical Society and the *Educational Times.*

Mr. Loewy has retained much of the elementary part of the late Dr. Lardner's treatise, having carefully revised it and brought it up to modern requirements. He has re-written, for the most part, the descriptive chapters on machines, clockwork, &c. Many new illustrations and a great number of solved exercises have been added, so that now the work is embellished with nearly 400 illustrations. An account is given of the modern units of force and work (the dyne, poundol, &c.). The result is a neat and readable book on properties of matter, theory of machinery, and illustrations of the application of mechanical principles in the industrial arts. We do not pretend to have read the work for it is full of matter, but what we have examined we have found interesting and carefully done. We have detected a few slips (typographical, chiefly) in the solutions. A good feature is an index.

The last book on our list is neatly got out and is doubtless adapted for the end in view, the author having written it for candidates for the Oxford and Cambridge Local Examinations. It is such a book as might have been compiled at any time within the last twenty-five years from the Cambridge text-books, for it keeps quite to the old Cambridge "lines;" it "aims at being simple, but not childishly so." The modern treatment of the subject has been altogether avoided. This is, perhaps, no fault of the author, but rather the exigencies of the above-named examinations have compelled him to move in this rut. There is a sufficient number of exercises taken from the examination papers, and a chapter is devoted to hints for, and examples of, the selection of problems. The figures generally are clearly drawn, but a cylinder on p. 43 is a sorry representation of such a solid.

OUR BOOK SHELF

Mikrographie der Glasbasalte von Hawaii: Petrographische Untersuchung. Von C. Fr. W. Krukenberg. (Tübingen, 1877.)

THE interesting facts made known of late years by Prof. Möhl, of Cassel, and Dr. Bořický, of Prague, as the result of their study of the microscopic characters of the vitreous and semi-vitreous rocks of basic composition, have rendered it eminently desirable that a thorough investigation of the remarkable lavas of the Sandwich Islands should be undertaken by some competent observer. We therefore hail the appearance of the monograph now before us as supplying a want which has been felt for some time past by all who are interested in micro-petrographic studies.

From the older analyses of the Sandwich Island lavas as tabulated by Herr Krukenberg, we learn that the composition of these rocks varies within very wide limits—the proportion of silica ranging from 39·74 to 59·80; the author's own analyses, however, would seem to indicate much less widely separated rocks as having been subjected to examination by him, for the proportions of silica are given as from 50·865 to 53·61. The most remarkable circumstance about the composition of these Hawaiian lavas is probably the large proportion of iron-oxide which they contain, the percentage of this substance ranging from 13 to 33 per cent., while alumina is only present in small quantity, or is sometimes altogether absent.

Herr Krukenberg first describes the curious structure revealed by the microscope in the compact basaltic glass in which are detected numerous beautiful examples of those skeleton crystals built up of crystallites to which Vogelsang first directed the attention of geologists, and to which the name of "chiasmoliths" has been applied. Among the perfectly-formed crystals porphyritically embedded in this compact or glassy mass, the author noticed felspar (both orthoclastic and plagioclastic) and olivine, but he failed to detect augite.

The curious forms assumed by the threads of Pele's hair are admirably described in the work before us, and are illustrated by numerous figures. Gas bubbles appear to be very common in these glass threads, and they are often drawn out into elongated cavities or fine capillary tubes. Minute crystals are sometimes seen in the midst of the glass threads, which sometimes exhibit a concentric structure and at others a series of transverse striations. In the ordinary porous glass lava the author finds structures intermediate between the chiasmoliths and the crystalline plates seen in Pele's hair; his drawings, indeed, very admirably illustrate the mode of development of crystals in glassy magmas. The last variety of the Sandwich Island lavas described in this monograph is the sphærulitic; but the sphærulites of the basaltic rocks do not appear to differ in any essential point of structure from those so well known as occurring in acid vitreous rocks.

In an appendix to the paper the author notices the existence in the Sandwich Islands of a true obsidian which yielded 76·10 per cent. of silica. The monograph is illustrated with four lithographic plates, and is a very valuable contribution to petrographic science. J. W. J.

Preventive Medicine in Relation to the Public Health. By A. Carpenter, M.D., C.S.S., Camb. (London: Simpkin, Marshall, and Co.)

UNDER the title of "Preventive Medicine" Dr. Carpenter has reprinted lectures which he gave, during the summer session of 1876, at St. Thomas's Hospital. They were addressed to students, and the form in which they were first given has been preserved. At a time when, in the words of the Prince of Wales's letter to the Society of Arts, "the supply of pure water to the population is exciting deep interest throughout the country," the volume will be found a convenient and ready *résumé* for those who wish to inform themselves on the more important questions that enter into the consideration of what is a good water supply, and what is to be done with fouled water. As is well known, Dr. Carpenter advocates sewage-farms as the proper way to dispose of sewage, and the chapters devoted to this subject enter into financial as well as scientific consideration. In speaking of the spread of epidemic diseases by water and by air Dr. Carpenter explains the germ theory, but we cannot find that he even alludes to any other possible explanation. It appears as if he regards the germ theory of disease as really *proved.* Is it?

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Phonograph

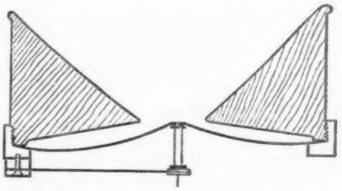
I HAVE received the following interesting letter from Dr. Blake, Boston, U.S.A. :— W. H. PREECE

"You may possibly be interested in some recent experiments which I have made with the phonograph, and unless you have been pursuing the same course, may find them worthy of repetition.

"I found that the groove in the cylinder, covered with tin-foil, became a resonator for the high scratching noise of the embossing point, materially interfering with the reproduction of the quality of the voice.

"By stretching a thin layer of rubber tissue over the cylinder this resonating effect was done away with and the scratching noise materially lessened. This experiment was new to Mr. Edison, and has since been repeated with like success.

"Since experiments made with the ferrotype telephone and phonograph-discs show that they transmit with almost astonishing accuracy the lighter over-tones of the human voice, but at the same time give especial prominence to certain over-tones to which the metal disc especially responds, I constructed a diaphragm upon the principle of the human drum membrane, to be used as a reproducing disc; the object being to employ a membrane which, from its structure and shape, would reproduce the lighter over-tones representing the quality of the voice, and at the same time 'cut off' the sharper exaggerated over-tones embossed as such by the metal disc upon the tin-foil. The results of the experiments with such a membrane were very



A small rod of light pine wood having a rubber pad at either end is placed between the boss which carries the embossing point and the centre of the membrane. This, the first form of disc constructed, worked very well.

gratifying. After embossing with the metal disc, the curved membrane was substituted, and the voice reproduced from the phonograph without the sharper over-tones, with much more natural and agreeable quality and with more than double intensity. On using the curved membrane for embossing as well as reproducing, I found, as would be expected, that the quality of the voice was more accurately represented, and that the embossing could be done at a distance of over fifteen feet from the phonograph, and be reproduced with clearness.

"Mr. Edison is now experimenting with this form of diaphragm, and, I understand, with very good results.

"The material used for these discs may be either stout felted paper (to be varnished on the outer surface when used for speaking) or drum-head, moistened and pressed into concave form before using. The principle governing the vibrations of such a disc is that of imparting the vibrations to the centre of a membrane the curve of which enables it to reproduce a large range of over-tones, its tension serving as a counterbalance to the central pressure. "CLARENCE J. BLAKE

"W. H. Preece, Esq., London."

Physical Science for Artists

WITH reference to Mr. Norman Lockyer's and Prof. Brücke's observations on the appearance presented by the shadow of the earth at sunset or sunrise (NATURE, vol. xviii. p. 223), I beg to be allowed to confirm them by my experience in Switzerland. Early starts for expeditions give one, among other good things, opportunities for seeing sunrise from the very beginning, and I have repeatedly seen the shadow of the earth, as it were, gradually driven down by the illuminated portion of the sky, the boundary between them being very well marked and roughly circular like the horizon, but I think with a greater apparent curvature. At this distance of time (some years) I cannot remember anything of an effect of foreshortening such as Prof. Brücke notices.

Once, in 1868, I saw an even more curious effect. As we stood at sunrise on a moderately sharp ridge running pretty closely north and south, at a height of 9,000 to 10,000 feet, there was an interval of appreciable duration in which it was a visible and striking fact that it was night on one side of the ridge and day on the other. F. POLLOCK

Savile Club, Savile Row, W., June 27

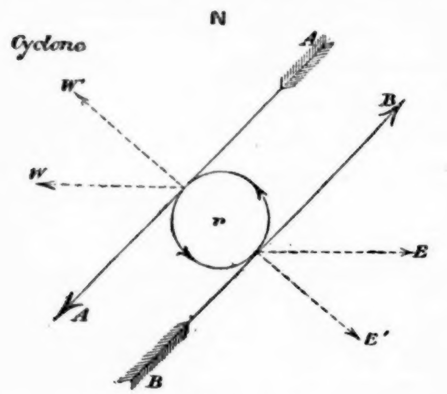
Cyclones and Anticyclones

I WILL endeavour to put into a written form the ideas which have occurred to me respecting the law which, as I suppose, connects and governs the atmospheric phenomena which I see referred to in the newspapers as cyclones and anticyclones. I have seen it stated, as the result of observation, that in whatever direction the wind may be blowing at any given time, if you place your back to it the barometer will be found to stand lower upon your left than upon your right. I have also seen it stated that what are termed cyclones are rotatory movements of the air occasioned by the meeting and passing one another of two currents of air moving in opposite, or nearly opposite, directions, and that these cyclones or rotatory storms, though differing much in area, have certain features common to most, if not all, of them; namely, that the direction of their rotation is from right to left, or, in other words, the opposite of the motion of the hands of a watch, and that in their centre is found a considerable diminution of atmospheric pressure. On the other hand, in what is termed an anticyclone, the direction of the rotatory movement is in the opposite direction, that is, from left to right, or in the same direction as the movement of the hands of a watch, while in the central region the barometer is found to be standing high.

These various phenomena appear to me to be closely connected one with the other, and to be, in fact, due to the rotation of the earth upon its axis, which, having regard to its spherical form, makes it inevitable that the superincumbent air at the equator must rotate with the earth under it at a much greater velocity than that which is near the pole. For it seems evident that a current of air coming from the north travels into a region which is moving to the east more quickly than itself, and will therefore present itself as a north-east wind to the inhabitants of the more northern latitude, and not only so, but will tend to arrest the air on its right or westerly hand, while it is left or abandoned by the more quickly eastward-moving air on its left or easterly hand. This consideration will explain, so far as northerly winds are concerned, the first-mentioned of the phenomena above referred to, namely, the lower glass on the left hand, the higher glass on the right. Taking next the case of a northerly wind, it will be obvious that in travelling northward it comes to a country moving westward more slowly than itself, and consequently appears as a north-west wind to the people over whose land it passes; and not only so, but by pressing on the air to the right, or eastward side, it increases pressure in that direction, while it tends to leave behind the more slowly moving air on its left, or westward side, thus again producing the first-mentioned phenomenon of a high glass on the right and a low glass on the left, so far as southerly winds are concerned. If this principle is considered with reference to a cyclone and the direction of the rotatory movement is also taken into account, it seems to be made clear that a cyclone is occasioned *by the meeting and passing each other of a northerly and southerly current so that they pass each other on the left hand respectively.*

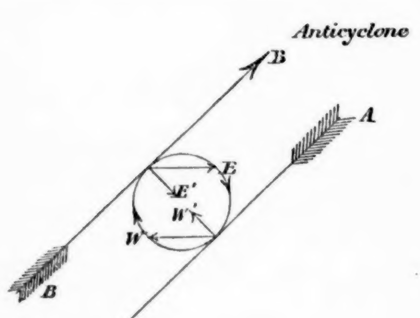
When this occurs the low pressure on the left or east side of the north wind coincides with the low pressure on the left or west side of the south wind, and thus a depression is formed round which the wind rotates. It follows that the west and south wind is found in the south and south-east side of the storm,

while the north-westerly current is on the north-west side, or as it is sometimes termed, the back of the storm. In the case of an anti-cyclone the whole thing is reversed. *The two currents pass each other on their respective right hands.* This enables the high glass on the right side of each to coincide with one another. The two winds instead of *dragging away from each other, are pushing against each other, and form a heap of air round which they*



CYCLONE.—A A, a north-east wind; B B, a south-west wind; W, westerly drift of A A due to difference of absolute velocities of earth's motion at different latitudes; W', effective part of W, in producing rarefaction at *r*; E', effective part of E as above. *Result*, rarefaction in centre of cyclone.

W ——— E



ANTICYCLONE.—*Mutatis mutandis* as cyclone. *Result*, condensation at centre of anticyclone.

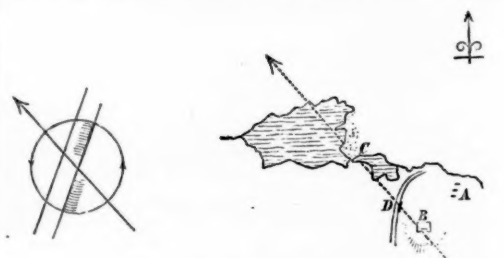
rotate, not necessarily in the opposite direction to that of the cyclone. It would be interesting to know whether an anti-cyclone travels from north-east to south-west. Whether it does so or not I do not know; but this is what would seem to follow if the above imperfectly-stated theory is a correct one.

EUSTACE BARHAM

Whirlwind

As meteorologists appear to be taking much interest in whirlwinds and waterspouts, you will perhaps allow me to offer you a few notes respecting a whirlwind that passed over a mountainous part of Northumberland on April 14, 1869, and left indisputable evidence of the direction in which it revolved, a fact of some importance, and one in general so difficult to ascertain, that after much research I have never yet met with a description of either whirlwind or waterspout that can be considered satisfactory in this respect.

I have long held the opinion that the smaller whirlwinds and waterspouts are of the same nature, and follow the same laws, as the greater cyclones, although Sir Wm. Reid, at p. 461, vol. i. of his "Law of Storms," is of a contrary opinion, founded on observations of waterspouts at sea, where it is extremely difficult to judge by the eye in which direction a spout is rotating. The cases where, as in America, attempts have been made to settle this point by the direction of trees thrown down by the whirlwind are very unsatisfactory; and there is nothing definite



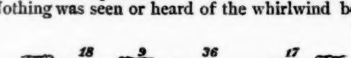
on this head to be met with in the description of upwards of three hundred whirlwinds described by Peltier in his work "Sur les Trombes."

The 14th of April, 1869, was exceedingly wild and stormy, and so dark at mid-day that we could scarcely see to write at a meeting of churchwardens in the vestry of Hexham Abbey Church. Having heard of the whirlwind at Sweethope, about ten miles north of Hexham, I went thither in July, 1869, accompanied by my friend Dr. James Smith, of Newcastle-upon-Tyne. We passed the night at Sweethope Farm (A), and examined the course of the meteor carefully. Masons were still engaged rebuilding a stable and boathouse (C) which stand at the northern extremity of the embankment that separates the larger from the smaller lake, from which issues the River Wansbeck, that flows past Morpeth, about twenty miles to the eastward.

The whirlwind was first noticed by the inmates of Mr. Robson's house, A, as it passed a small plantation on a hill at B, and was seen to travel in a north-westerly direction across the road at D, along the embankment between the two lakes, over the boathouse, C. From this point it passed a plantation of young trees, through which it cut a broad lane, and afterwards overturned a haystack.

Mr. Robson informed me, in a letter, that "trees were torn up by fifties, some broken off about midway, and carried a considerable distance in the air. Stones were turned up that would have taxed the powers of three or four strong men. Several sheep and lambs were lifted up into the air and killed by the fall; others were carried up, and, falling into the lake, were drowned. There was a tremendous thunderstorm, with forked lightning and very large hailstones. It did not travel very fast, and was like a large volume of smoke."

The boathouse was entirely unroofed and the nails drawn out of the planks of a floor of a room in the upper part of the building. The small plantation at A is 812 feet above the sea-level. Nothing was seen or heard of the whirlwind beyond the



limits of the diagram, which is copied from the Ordnance Survey Maps on the scale of an inch to a mile.

So far, the Sweethope whirlwind presented only the usual features of its class, and we were about to depart, after some good sport among the fish in the lakes, when Mr. Robson's son mentioned to me that the whirlwind, in crossing the road (at D), had thrown part of the wall into the road and another part into the field, a significant fact of which we at once proceeded to examine the details. At the point D in the diagram the wall runs in a direction nearly north by east, and has been about four feet high. At the southern end we found about two feet of the

upper part for a distance of eighteen yards thrown into the field. Then came about 9 yards of wall quite undisturbed, and afterwards thirty-six yards half down, but lying in the roadway on the opposite side of the wall. About seventeen yards of the coping-stone at the extreme northern end of the broken wall was also thrown into the road.

Fortunately the whole lay at the time of our visit just as when the whirlwind had passed, and proved conclusively that, in this case at least, the order of rotation was the same as that of the cyclones of the northern hemisphere. THOMAS DOBSON

Marine School, South Shields, June 22

Zoological Geography—Didus and Didunculus

I AM at a loss to understand how *Didunculus* can be called "a near congener" of the Dodo, as Mr. Searles V. Wood, apparently following Dr. Litton Forbes (whose paper I have not seen), terms it (*suprà*, p. 220). The two birds, so far from being congeneric, belong to perfectly distinct groups of the Order *Columbæ*, and nearly thirty years ago Bonaparte treated them as the types of distinct families—*Dididæ* and *Didunculidæ*—an example which has been generally followed by the best authorities. If Mr. Wood will refer to a paper in the *Philosophical Transactions* for 1869 (pp. 327–362) I think he will see that there is good ground for not attaching much importance to the slight and superficial characters in which *Didunculus* resembles the *Dididæ*. ALFRED NEWTON

June 30

A Subject-Index to Scientific Periodical Literature

I BEG permission to ventilate in your columns a subject which must make itself felt more or less to all your readers, viz., the want of some subject-index to the vast amount of material scattered about in the numerous scientific periodical publications of the present day. It is true we have the admirable catalogue of the Royal Society, but unless you are acquainted with the name of every author who has written on your subject, it is nearly hopeless attempting a complete bibliography of it. Now I would suggest whether an index to the Royal Society's catalogue cannot be made on the same plan that has been adopted by the committee of the new edition of "Poole's Index," viz., by getting different societies, libraries, or individuals to take certain parts of the work. The following is a short abstract of how this committee have set about their work; any of your readers who wish for further information will find it at pp. 109–206 of the "Transactions and Proceedings of the Conference of Librarians, London, 1878," and on p. 201 a short specimen may be seen. The index is made on sheets of foolscap, and the indexer has nothing to do with alphabetical arrangement; he makes his entries in the order the articles occur in the volume at which he is working; these sheets are then sent to the editors, who cut them into slips and work them into alphabetical order with the material coming in from other sources. By this method complete uniformity is maintained; for should the indexer have a peculiar idea of his own how any particular part should be done, his peculiarity is put right at the central bureau or editorial office.

I have said this should be an index to the Royal Society's catalogue, but if this scheme is ever carried into execution I would strongly urge that the index should be made from the periodicals themselves, and not from the entries in the Royal Society's catalogue, as it is absolutely impossible to index a paper properly from the title only; and another advantage is that under this plan the work could be better carried out, as each indexer could confine himself to his own branch of study; whereas if the index were made from the catalogue itself, it must be cut up into alphabetical portions, and each man would have to do a variety of subjects. This may seem to many too large a matter even for consideration, but for many years so was a good alphabetical catalogue of the different scientific papers; this has been conquered by the Royal Society, and if that learned body would constitute itself the central bureau, I think willing workers would soon be found, and the success of the index be assured. Of course all this would cost money, but surely an appeal might fairly be made to scientific societies and individuals to help in this work, which would be so great a help to the "advancement of science." JAS. B. BAILEY

Oxford

A NEW TRIUMPH OF CHEMICAL SYNTHESIS

THE year 1868 was a marked epoch in the progress of chemical synthesis as well as of tinctorial processes. The German chemists, Profs. Graebe and Liebermann, succeeded at that date in preparing from the hydrocarbon anthracene manufactured from coal tar the brilliant dyestuffs hitherto won from madder, and in establishing also the chemical constitution of these various compounds and their relationship to other well-known bodies. This was the first instance in which the chemist had succeeded in artificially preparing colours occurring in the vegetable kingdom; and although the manufacture of artificial madder colouring matters has assumed at the present day colossal proportions and bids fair to entirely supersede the preparation of the natural products, it has hitherto remained the only instance of the kind in the history of chemistry, all other vegetable and animal dyes obstinately refusing to disclose the secret of their composition and be classified among the compounds of well-defined molecular structure. Within the past few weeks the madder colours have ceased to occupy this unique position. Modern chemistry has succeeded in preparing synthetically none other than common indigo, the well-known product of the *Isatis tinctoria*, and *Nerium tinctorium* of India and South America.

This discovery is likewise due to a German chemist, Prof. A. Baeyer, the genial successor to the chair of Liebig at Munich, one of the most indefatigable and successful investigators of our day. For a score of years he has been seeking to solve the problem of the constitution of indigo and its synthetical preparation. Slowly and patiently he has gathered together and elaborated one fact after another, until finally, at the last session of the German Chemical Society, he was able to announce the completion of the long research and the discovery of the last link in the chain of synthetic reactions leading to the formation of indigo.

We will sketch briefly the various steps in this synthesis, which is not only one of the most brilliant chemical achievements of the present year, but affords an unusually interesting glimpse into the methods and aims of the modern chemist.

Indigo blue, or indigotine, possesses the formula C_8H_5NO, and, from the products of its decomposition, aniline, orthoamidobenzoic acid, &c., has long been regarded as closely allied to the benzene series. Attempts without number have been made to show the nature of this connection by starting from benzene compounds, but hitherto with fruitless results. As in the case of the alizarine compounds, where Graebe and Liebermann first found that anthracene was obtained from alizarine by reducing agents, so has the first step in the solution of the indigo problem been to study carefully the various compounds resulting from successive decompositions, each in turn yielding a body of a simpler constitution. Passing from one compound to another, Prof. Baeyer finally reached alpha-toluic acid or phenylacetic acid, $C_6H_5.CH_2.COOH$, a not uncommon body, easily prepared from cyanide of benzyl. Here he stopped, and began to retrace his footsteps.

The first reaction was to replace one of the hydrogen atoms in the phenylic group of *phenylacetic acid,*

$$\text{(A.)}\quad C_6H_5.CH_2.COOH,$$

by the group NO_2—a familiar operation effected by treatment with nitric acid—and giving, among other compounds, *ortho-nitrophenylacetic acid,*

$$\text{(B.)}\quad C_6H_4\!\left\langle\begin{matrix}CH_2.COOH\\ NO_2\end{matrix}\right. .$$

This, when reduced by nascent hydrogen—*i.e.*, submitted to treatment with a mixture of tin and hydrochloric

acid—gives the corresponding *ortho-amidophenylacetic acid*,

$$(C.)\quad C_6H_4\left\langle\begin{array}{l}CH_2.COOH\\ NH_2\end{array}\right. .$$

In a neutral solution this acid is changed into its anhydride by the elimination of a molecule of water forming

$$(D.)\quad C_6H_4\left\langle\begin{array}{l}CH_2.CO\\ NH\end{array}\right\rangle .$$

And here we leave the long names indicative of the structural composition of the compounds: for Prof. Baeyer has found that this anhydride is identical with oxindol, one of the derivatives of indigo. The next steps are to introduce the nitroso group, NO, forming *nitroso-oxindol*,

$$(E.)\quad C_6H_4\left\langle\begin{array}{l}CH(NO).CO\\ NH\end{array}\right\rangle ,$$

and to reduce this as before to *amido-oxindol*,

$$(F.)\quad C_6H_4\left\langle\begin{array}{l}CH(NH_2).CO\\ NH\end{array}\right\rangle .$$

This compound, when oxidised with chloride of iron or copper, or with nitrous acid, is changed entirely into *isatin*,

$$(G.)\quad C_6H_4\left\langle\begin{array}{l}COCO\\ NH\end{array}\right\rangle ,$$

a substance resulting from the oxidation of indigo, which already in 1870 Prof. Baeyer, by the action of phosphorus trichloride, had changed back into *indigo-blue*,

$$(H.)\quad \begin{array}{l}N.C_6H_4.CO.CH\\ \parallel \qquad\qquad\quad \parallel\\ N.C_6H_4.CO.CH\end{array} ,$$

by the union of two molecules and the elimination of two atoms of oxygen. With this last transformation the synthesis was completed. Although the operations are too numerous and too costly to allow at present any hope of the practical utilisation of this ingenious succession of reactions, the series presents still a remarkable example of the possibilities in the hands of the organic chemist, of the powers of combination requisite for the successful pursuit of modern synthetical research, and of the attractions which draw to this province the majority of our leading chemists. T. H. N.

BIOLOGICAL NOTES

THE COMET-FORMS OF STAR-FISHES.—Ernst Haeckel, in a recent number of the *Zeitsch. wiss. Zool.* (1878, Supplement 3), draws attention to these forms, and the support which the facts recently established as to the power possessed by certain star-fishes of multiplying by throwing off their arms, lends to his theory of the origin of the Echinoderma by the continually increasing integration or centralisation of a radially-connected colony of worm-like persons. The phenomenon of self-division across the disc has been observed in species of Asteracanthion (Uraster) by Lütken and Kowalewsky; the production of comet-forms depends, however, on the separation of single arms, which then reproduce the whole disc and remaining arms by budding. Martens, in 1866, observed this in the case of a Luidia (Ophidiaster) in the Red Sea. Kowalewsky found that it was a common process with similar species and same locality. Sars observed it in Brisinga. Studer has described the regular occurrence in Labidiaster of a spontaneous casting off of the arms, but not the regeneration of disc and arms on the separated arms. Sir John Dalyell observed the whole process of reproduction of the disc on a single detached arm of *Asteracanthion* (*Uraster*) *glacialis*. The support which these facts lend to the "Astrocormus" theory is not of that value which Haeckel would assign to them, for such physiological tests of morphological doctrine are necessarily delusive. We have only to remember the facts as to cuttings and graftings in organisms generally in order to see that no special argument can be based upon them as to details of morphological composition. Haeckel proposes to divide the Echinoderms or Estrellæ as follows:—

Group I.—Protestrellæ: Class I. Asteriæ.
Group II.—Anthestrellæ: Class 2. Ophiuræ; Class 3. Crinoida.
Group III.—Thecestrellæ: Class 4. Blastoida; Class 5. Echinida; Class 6. Holothuriæ.

The second and third groups have developed from the first as diverging branches, whilst the Holothuriæ are modified descendants of Echinida. The resemblances between Gephyrea and Holothurians are declared by Haeckel to be entirely due to parallel adaptation (homoplasy), the pair of branched excretory organs of Bonellia, &c., being totally unrelated to the dendriform water-lungs of Holothurians, which are *five* in number in primitive forms and agree with branched inter-radial cœca (not the so-called "hepatic" cœca) of the intestine found in certain star-fishes (Archaster, Astropecten). E. R. L.

THE TRANSFORMATIONS OF BLISTER-BEETLES.—According to Dr. C. V. Riley, who has studied these creatures for some years, the young of all vesicants belonging to the Meloidæ, develop in the cells of honey-making bees, first devouring the egg of the bee and then the honey and bee-bread. They are all remarkable for their hyper-metamorphosis, passing through several larval stages. The young Meloës are at first simple larvæ called triungulins, running actively about, climbing to flowers visited by bees, to which they attach themselves. They have stout thighs and claws, but feeble jaws. Only a few can get attached to the proper bees, the others must perish. Once in the cell the creature eats the bees' egg, and then moults and assumes the second larval condition. In this state it is clumsy and little locomotive, and feeds on the honey store. It then becomes a pseudo-pupa, and later a third larva within the partially-rent skin; the true pupa stage being still later. Another genus of the family is *Hornia*, of which a remarkable species is found around St. Louis, with the elytra and wings extremely reduced. The Hornia resides mostly in the galleries of *Anthrophora sponsa*, out of which it can scarcely crawl. The hyper-metamorphosis is of the same character as in Meloë (*American Naturalist*, April). The genus Epicauta exhibits a very parallel history.

CURIOUS SOCIAL RELATIONS.—Stories about prairie dogs, owls, and rattlesnakes are well known, but trustworthy scientific observations about them are not very numerous. Mr. S. W. Williston (*American Naturalist*, April) gives the results of several years personal observations. He says that prairie dogs can thrive even in the dry scorched deserts of Southern Colorado, and the cold bleak Laramie plains. They are very provident in summer for winter, but yet emerge in spring much reduced in plumpness. At the approach of danger signals of distress are given, and when actually attacked they get into their mounds with wonderful speed, escaping beyond reach even when a rifle has scattered the brains of the animal. The burrowing owl not unfrequently occupies the same hole; the prairie dog pays little heed to it but tolerates it. The owls present a most ridiculous appearance, standing during the day at the entrance of their dwellings, in an attitude of the deepest contemplation; at the appearance of an intruder they begin the most comical bowings and curtsies, and at last with a cry like a watchman's rattle fly off to a neighbouring mound. The rattlesnakes cannot be said to be friendly with either of these creatures. Out of many hundreds of rattlesnakes destroyed by Mr. Williston, a number had devoured the young of the prairie dog, but none the young owl. The occupancy of a burrow by a

rattlesnake does not, however, prevent the entrance of the dog; the rattlesnake is never wanton, and only defends itself and takes necessary food. The dog will pass by it to enter its burrow without being molested.

CLEISTOGAMOUS FLOWERS IN GRASSES.—Mr. C. G. Pringle has discovered in Western Vermont cleistogamous flowers in several grasses, especially *Danthonia spicata*. The latter has many flowers totally concealed in the sheaths, the glumes and pales being much simplified, but the sexual parts being perfect and producing seeds. This plant is spreading rapidly in Vermont. The seeds borne on the top of the culm fall mostly at midsummer and lodge close to the parent plant, but the concealed seeds stored around the culm remain till these are disjointed and driven about by the autumn and winter winds; consequently, a wide means of dissemination is provided.

ON THE VIEW OF THE PROPAGATION OF SOUND DEMANDED BY THE ACCEPTANCE OF THE KINETIC THEORY OF GASES

1. IT is an accepted fact that the molecules of a gas are *in motion* among themselves in their normal state, and incapable of acting on each other at a distance; so that a theory of the propagation of sound, based upon the contrary suppositions that the molecules of a gas are *at rest* in their normal state and capable of acting on each other at a distance, cannot possibly be tenable. It thereby becomes necessary to inquire what view of the propagation of sound is demanded by the acceptance of the kinetic theory of gases; and this inquiry would appear to be all the more important in view of the fact that the mechanism of the propagation of sound in gases forms the physical basis of a great part of acoustics, or the groundwork upon which a number of its problems depend—the *physical basis* that underlies a system being admittedly the most important of the whole.

2. The molecules of a gas being in motion among themselves, it becomes evident after a very brief consideration of the question, that the only way in which a small impulse (or variation of velocity) termed a "wave" can be propagated through a gas, is by the exchange of motion normally going on among the molecules of the gas. *For the molecules have no other mode of acting upon each other, excepting by exchange of motion.* The rate at which this "wave" (or small variation of velocity) is propagated through the gas, will therefore depend on *the rate at which the molecules exchange motion*, i.e. on the normal velocity of the molecules of the gas. The sole condition determining the velocity of propagation of sound in a gas is therefore the velocity of the molecules of the gas. Here, therefore, we have a very simple condition for the velocity of sound (on the basis of the kinetic theory), or the velocity of sound becomes thus dependent only on *one* condition. This simplicity is characteristic of the rest of the kinetic theory, and is (it may be added) the recognised quality of scientific truth. In gases of the most diverse densities, specific gravities, pressures, and temperatures, the velocity of sound is only dependent on *one* condition, viz., *the velocity of the molecules*, of the gas.

3. That the velocity of sound is independent of *density*, will be evident from the consideration that the molecules of gas are almost indefinitely small compared with their length of free path, and also the time of a collision is indefinitely small compared with the time taken to traverse the free path, so that it does not matter how many collisions (or exchanges of motion) occur along the line of passage of the impulse (or "wave"), but simply on the *rate of motion* of the molecules conveying the impulse. So (to take a simple analogy by way of illustration), it does not matter how many couriers are along the line of route conveying a message, but on the rate of motion of the couriers. Adding to the number of molecules in unit of volume of a gas (or adding to the density) does not, therefore, alter the velocity of sound in a gas, because it does not alter the *velocity* of the molecules which (by their exchange of motion) propagate the wave. The old theory supposes that the velocity of sound is here unaltered, because increased density *diminishes* the velocity of propagation of the wave, and increased pressure (attendant on the increased density) *augments* the velocity of the wave, and thus the two conditions counteract each other. On the kinetic theory, neither of these conditions can have any effect, and therefore the explanation of the unaltered velocity of the wave is perfectly simple, being the cosequence of the *unaltered* velocity of the molecules which propagate it. It is unnecessary to comment on the contrasted simplicity of the view on the kinetic theory; which is, moreover, the *true* view, if the kinetic theory be accepted.

4. That the velocity of sound on the kinetic theory is independent of *pressure*, is sufficiently clear at first sight; for pressure evidently could not influence the rate at which the molecules exchange motion among each other, through which means alone the impulse is conveyed.

5. That change of *specific gravity* (or molecular weight) can by itself have no effect on the velocity of the sound-wave, is evident from the fact that it cannot matter whether the molecules exchanging motion among each other (and propagating the impulse) be heavy or light, provided their velocity be the same. It has been (as is known) demonstrated, generally from dynamical principles, that a system of bodies in free collision all tend to acquire the *same* absolute energy. Hence the velocity of each body depends on its mass (or varies inversely as the square root of its mass). So the mass of the molecules of hydrogen being (as is known) one sixteenth that of the molecules of oxygen, the velocity of the molecules of hydrogen is four times greater than that of the molecules of oxygen; and accordingly *for this reason* the velocity of sound in hydrogen is exactly four times greater than its velocity in oxygen—not, however, because the molecules propagating the wave are heavy or light. The molecules of hydrogen in their normal exchange of motion, move at four times the speed (compared with those of oxygen), and therefore propagate by this exchange of motion the sound-wave at four times the speed. The specific gravity (or molecular weight) of the gas has evidently nothing whatever to do with the rate of propagation of sound. The reason why the velocity of propagation of sound *appears* to depend on the molecular weight of the gas is because the *velocity* of the molecules of the gas depends on the molecular weight.

6. So also the velocity of sound is independent of the *temperature*, provided the molecular velocity remains the same. Of course this could only be true of *different* gases (*i.e.*, of gases of different molecular weights), which—as is known—may be at different temperatures and yet possess the *same* molecular velocities. In one and the same gas of course the temperature could not be altered without altering the molecular velocity, for the "heat" itself consists in the motion of the molecules of the gas. This is therefore evidently the *cause* why the application of heat to a gas increases the velocity of sound. The addition of "heat" simply represents (as is known) the addition of velocity to the molecules of the gas, which consequently, by their exchange of motion, propagate the wave at a greater rate. The explanation of the increased velocity of sound in a heated gas is thus simple and direct. On the old theory the increased velocity of the sound-wave in a heated gas is referred to the diminished *density* of the heated gas (attendant on its expansion); and when the gas is confined, to its increased pressure. Surely this is at best a somewhat laboured and

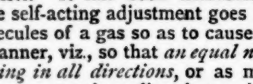
ndirect way of accounting for a fact, and (as we have seen) according to the *kinetic* theory it cannot hold, since according to this theory, *density* and *pressure* can have no influence on the velocity of the wave, and on the other hand it is *a known fact* that the velocity of the molecules in their exchange of motion (by which means alone they can propagate the wave) is *increased* by the heat—indeed this augmentation of velocity itself represents the added "heat." This explanation of the increased velocity of a sound-wave in a heated gas commends itself therefore not only by its simplicity, but as a matter of scientific truth.

7. This serves also to explain in a direct and simple manner the relation the velocity of sound in a gas bears to the temperature. The absolute "temperature" of the gas represents (as is known) simply the energy of the molecules. The velocity of the molecules (as of any moving system of bodies) is proportional to the square root of their energy, and therefore proportional to the square root of the absolute temperature (since the "temperature" represents the energy). The velocity of sound, therefore (which is proportional to the velocity of the molecules), is thereby proportional to the square root of the absolute temperature of the gas.

8. To afford a more distinct idea of the mode of propagation of the wave and the physical effect (condensation and rarefaction) produced on the gas by its passage, the following considerations may serve. It is an important fact to keep in view that a system of bodies in free collision, such as the molecules of a gas, do not move in a mere chance or perfectly irregular manner, but a certain *regularity* exists. It has been mathematically proved that a forcible self-acting adjustment goes on among the colliding molecules of a gas so as to cause them to move in a *special* manner, viz., so that *an equal number of molecules are moving in all directions*, or as many molecules are moving in any one given direction as in the opposite. This mode of motion, if artificially disturbed, will correct itself. It is this special mode of motion (or movement of the molecules *equally* towards *all* directions) that produces the perfect equilibrium of pressure in all directions, observed in a gas.

9. From the fact that as many molecules are moving in any one direction as in the opposite; it follows that if an imaginary plane be placed in any position outside a vessel containing gas, the number of molecules (in the vessel) which at any instant are approaching the plane, is equal to the number which at the same instant are receding from it. Or otherwise, if we suppose any imaginary straight line in a gas, and visualise the molecules upon this line, then, *as many molecules are moving in one direction as in the opposite.* In the case of those molecules which are moving *obliquely* to the line, the resolved component of the motion in the direction of the line can be taken. This consideration enables the mode of motion of the molecules of a gas in its normal state, and the manner of propagation of waves through that mode of motion, to be illustrated in a very simple manner.

10. In the annexed diagram, let 1, 2, 3, &c., represent a line of spheres moving in such a way that *as many spheres are moving in one direction as in the opposite.* All the spheres marked with the odd numbers may be supposed



to move in one direction, while those marked with the even numbers move simultaneously in the reverse direction, the *vis viva* in the one direction balancing that in the opposite direction (as is the case with a gas). Each alternate sphere thus simply oscillates backwards and forwards in opposite directions within the limits represented by the dotted lines in the diagram, the spheres continually rebounding from each other, and the line of spheres tending to open out or expand and separate the final controlling surfaces A and B (like the expansive action of a gas). It will be observed that this is in *principle* the only mode of motion possible by which the spheres can be in equilibrium; or half move in one direction and half in the opposite, so that the centre of gravity of the whole is at rest, in analogy with the centre of gravity of a portion of gas (the *vis viva* being at the same time balanced). There are only minute differences of detail as regards the comparison with a gas, none of *principle.* One detail is that every *alternate* molecule (in a line of molecules taken in a gas) does not necessarily move in an opposite direction, but it is rigidly true (on account of the vast multiplicity of molecules) that in any appreciable portion of a line taken in a gas, as many molecules are moving in one direction as in the opposite; for if not, the gas could not be in equilibrium in the direction of this line, whereas it is known to be in equilibrium in *every* direction. Another detail is that some of the molecules of a gas are moving *obliquely* to such an imaginary line, so that the mean path of the molecules is generally greater than that represented by the spheres. These details cannot however in the least affect the *principle*, and therefore the above method of illustration will serve (keeping in view the small differences mentioned) to convey a perfectly just idea of the character of the motion of the molecules of a gas in its normal state, and the way in which through that mode of motion "waves" are propagated through the gas. It is evident that an illustration is desirable in order to visualise clearly the facts.[1]

11. Suppose, now, a slow oscillatory motion in the form of a movement of vibration to be communicated to the plane A. The plane B may be supposed removed and the line of spheres extended indefinitely from the plane A. Then at the first forward swing of the plane A, the sphere 1 will receive an increment of velocity which it will transfer by collision to sphere 2, the sphere 1 returning with its normal velocity to the plane, and receiving from it a second increment, &c. By the forward swing of the plane, a succession of small increments of velocity will thus be propagated in the form of a pulse or semi-wave along the line of spheres, the velocity of propagation of the pulse being that of the spheres themselves. By the backward swing of the plane (to finish one complete vibration) a series of small decrements of velocity forming the second half of the wave will be propagated in precisely the same manner along the line of spheres. Owing to the succession of increments of velocity received by the spheres in the first half of the wave, these spheres will be shifted bodily forwards (to a slight extent), and owing to the succession of decrements of velocity sustained by the spheres in the second half of the wave, these spheres will be shifted (to a slight extent) bodily backwards, an alternate closing and opening out of the line of spheres corresponding to "condensations" and "rarefactions" being the result. There is only one slight (quantitative) difference in the case of an actual gas. Owing to the fact that some of the molecules in the case of a gas are moving (at the instant of passage of the wave) *obliquely* to the line of propagation of the wave, the rate of advance of the wave along the line of propagation will necessarily be somewhat slower than the velocity of the molecules which propagate it. It is (to take a homely illustration) as if some couriers were transmitting a message, and some of them were moving obliquely to the line of transmission of the message, when evidently the rate of transmission would be less than the velocity of the couriers. In order to obtain the true rate of propagation of the wave in the gas, the oblique motions of the molecules must be taken into account.

12. In connection with a former paper[2] bearing on this

[1] The mere fact of molecules, in the case of a gas, shifting their positions (through diffusion) can of course make no difference, since the *same character* of motion is rigidly kept up.

[2] *Phil. Mag.*, June, 1877.

subject, the true mathematical expression for the velocity of the wave in terms of that of the molecules of the gas has been determined by Prof. Maxwell. The expression is—

Velocity of wave equals $\frac{\sqrt{5}}{3}$ into the velocity of the molecules. This expression requires a slight additional correction in the case of most gases, owing to the movements of *rotation* developed at the collisions of the molecules, depending on their more or less irregular shape, which rotation calculably must delay the wave to a certain extent. According to the experimental results of Kundt and Warburg, the above expression for the velocity of sound in terms of that of the molecules holds exactly true (without correction) for vapour of mercury (whose molecules, it might perhaps be remarked, are simple or monatomic). The slight deviations from the above constant for the velocity of the wave that one observes in fact, are quite consistent with what one would expect from theory.

13. It may be observed that all the usual apparatus for illustrating sound-waves of course applies to the kinetic theory, as such apparatus is only intended to show the effect produced on the *mass* of air, or the condensations and rarefactions, without exhibiting the molecular mechanism that underlies it. A true view of the mode of propagation of the wave and the manner in which the condensations and rarefactions are produced at its passage, can only be obtained by visualising the fact that the molecules of gas are *in motion* in the normal state of the gas, in accordance with the accepted kinetic theory of gases.[1]

14. The kinetic theory thus reduces the conditions on which the velocity of sound in a gas depends to *one*, viz., the *velocity of the molecules of the gas*. It is not, however, this simplification alone that should recommend it, for it is not a mere question of choice or preference of one view over another, but a question of *fact*. For a theory of the conditions physically affecting the velocity of sound and its mode of propagation that may apply to one view as to the constitution of a gas (viz., the old view where the molecules are supposed *at rest*), cannot possibly apply to the diametrically opposite view of gaseous constitution represented by the accepted kinetic theory. It would appear desirable and fitting that the kinetic theory, having been applied so generally in other respects, should find a general application to so important and fundamental a fact affecting a gas as the propagation of sound in it.

15. Since the *physical basis* of a system is admittedly the most important of the whole, it would appear reasonable to expect that the investigation of problems in acoustics might gain by regarding the propagation of sound on the true physical basis represented by the accepted kinetic theory of gases; or by taking a true physical basis to ground the investigations upon, instead of one (based upon the old view of gaseous constitution) that admittedly does not harmonise with the facts.

NOTE.—It has recently come to my knowledge that two papers have been lately published on this subject, one by Prof. Roiti, of Florence (*Nuovo Cimento*, 1877), the other by Prof. J. H. Hoorweg (*Archiv Néer.*, xi., 1876), a brief abstract of which also appears in *Beiblätter zu den Annalen der Physik und Chemie* (vol. i. part 4, p. 209, 1877). Though the latter of these papers appears to precede mine (*Phil. Mag.*, June, 1877), I may add that a sketch of the same theory appears in a little book ("Physics of the Ether," E. and F. N. Spon), published by me in 1875. There is also an interesting paper by Mr. J. J. Waterston (*Phil. Mag.*, 1859, supp. to vol. 16), in which he proposes to illustrate the propagation of waves by a system of spheres, but he does not go into the explanation as to how the motion he assigns to the spheres can properly represent the case of a gas in its normal state. There are, nevertheless, points of interest in the paper.

S. TOLVER PRESTON

[1] It would appear not unreasonable to conclude that a realisation of the *molecular basis* underlying the propagation of sound, according to the accepted kinetic theory, might be able to throw some light on the investigations in connection with the telephone and other allied instruments, where the *molecular basis* of the phenomena would seem to be the essential point to be considered.

WHAT IS MORPHOLOGY?[1]

IF those of us who have laboured up the hill of life revert to the studies of our youth, I think we shall not remember to have heard our teachers speak of the "Morphology of Animals." I cannot remember when or where I first met with the word; although the idea itself with regard to plants, has been familiar to me for nearly forty years, that is, since the time when I became possessed of "Lindley's Introduction to Botany;" but he used the term "Organography." The term "Morphology" was used by Schleiden in his "Principles of Scientific Botany" at least thirty years ago; and I may say in passing that the study of that work was one of the best preparations I received for the work I have undertaken since.

A comparison of the mode in which both plants and animals are developed was suggested to me, if not for the first time, yet then with new force, by reading Johann Müller's "Physiology of Man;" especially in the part on Generation, and more especially in his statement of, and criticisms upon, Caspar J. Wolff's "Theory of Generation," which was published at Halle in 1759. The very mention of this date is interesting, for this is evidently the time, and this work of Wolff's was surely the work, which suggested to the great, rich mind of Goethe the idea of an underlying unity amid all the diversity of vegetable and animal forms. How fruitful this conception of the simplicity and unity of vegetable and animal patterns has been, I need not tell you; for more than a century it has been yielding precious and ever increasing results. It was natural, therefore, that a division of biology so new and so fascinating, should gain for itself a name: and as naturalists had been from time immemorial familiar with the *metamorphosis* of certain types, the term "morphology" which especially treats of such changes in the individual life-history of a plant or of an animal, was natural, easy, and appropriate.

The *à priori* dreams which made the study of vertebrate morphology appear transcendental, and indeed gave it that title as a cognomen, caused great loss of time and of talent: and if Prof. Huxley had done nothing else whatever than dispel the glamour of these dreams, he would have deserved well of his age. His "Croonian Lecture," delivered at the Royal Society about twenty years ago, was as "a trumpet that gives a certain sound;" the dreamers awoke from their dreams, and became the workers, who since that time have wrought with labour and travail night and day. But the science of morphology, which had become an elegant pastime here, had long before Prof. Huxley's time found a noble band of workers in Germany; from that land came the dream; in that land arose the workers; the labours of Rathke, von Baer, and Reichert were ready to the hand of our biological reformer. After these, who were the chiefs of the band, came others, all men of name and renown; "but they attained not to the first three."

My own indebtedness is primarily to Johann Müller, who in his "Physiology of Man," already referred to, gave such an excellent abstract of the labours of the embryologists, his countrymen. I ought not to forget his lamented translator, Dr. Baly; for in the original Müller's work was a sealed book to me, and indeed would be now.

The fact that all organic beings pass through various stages, and run a certain round of life, is now becoming

[1] The first of a course of lectures "On the Morphology of the Batrachia," delivered at the Royal College of Surgeons, by Prof. W. K. Parker, F.R.S.

generally known. In the midst of the very beginnings of life the unspeakably minute monads, as the beautiful researches of Dallinger and Drysdale show, pass through several stages in their individual life-history. All the intervening living forms, between the monad and the man pass through several stages. The "Seven Ages" attributed by the poet to man are preceded by twice seven stages.

In all times the insects showed the wonderful working of the morphological force; the poets noticed these facts and sang of them; the philosophers, also, and reasoned upon them; but it was left for us to learn that these facts are not unique, but universal. Nevertheless, "the bee who is small amongst those that fly, and yet her fruit is the chief of sweet things," and that still smaller creature, the wise-hearted ant, architect, soldier, and lawgiver; these, and the other members of the insect-class, are metamorphosed *openly*. So, also, are the amphibia among the vertebrates, for instance, the frog and the newt, whose changes of form are so familiar to us. Still, for the most part, in the vertebrata "these things *are* done in a corner;" their most important changes of form are hidden from unassisted vision; to search out those secrets is the work of the morphologist.

Here, however, I will let "that old man eloquent"—Lord Bacon—speak for me; he says that Solomon, who was a great example with him, did "compile a Natural History of all verdure, from the cedar upon the mountain to the moss upon the wall (which is but a rudiment between putrefaction and an herb), and also of all things that breathe or move. Nay, the same Solomon, the king, although he excelled in the glory of treasure and magnificent buildings, of shipping and navigation, of service and attendance, of fame and renown, and the like, yet he maketh no claim to any of those glories, but only to the glory of inquisition of truth; for so he saith expressly, 'The glory of God is to conceal a thing, but the glory of the king is to find it out;' as if, according to the innocent play of children, the Divine Majesty took delight to hide his works, to the end to have them found out; and as if kings could not obtain a greater honour than to be God's playfellows in that game; considering the great commandment of wits and means, whereby nothing needeth to be hidden from them."

It seems to us now a little thing for a great mind meditating upon the form of a vertebrated animal to think that the axial structures should pass into the skull, when the main nervous axis so manifestly expands to become the brain. Yet men were held in bondage from generation to generation by the force of mere teleological ideas, that do but as Bacon expresses it, "Slug and stay the ship from sailing." In one place he compares people who will have all these meanings and ends of things at any cost, and who cannot bear to look at things in the "dry light" of their efficient causes, to those low and sensual people of whom one reads in holy writ, who accounted the manna as poor, thin diet, and clamoured for the onions, the leak, and the garlic, that flavoured the flesh-pots of Egypt. Now, however, the study of structures, according to their mere uses, and the imagining of ideal exemplars, these modes, the one imperfect and the other illusory, are giving place to the observation of the rise and progress in life of living creatures.

This rise and progress may be traced *gradationally;* which is a tracing of form after form in the adult animals existing at the present time; a most profitable study surely. To this has been added (within the last century almost) the investigation of forms that have become extinct; here, in "palæontology," we come athwart forms that are lower in type than their nearest relatives now living. Lower, and more generalised are they: and thus the mind is led to look towards the causes that have operated in the extinction of the old, rough, archaic forms, and the production or creation of the "lovely living things" that now adorn the earth. These are very often smaller, and, as a rule, more specialised in all respects, beautified, refined, and elevated in type beyond anything that could have been seen in their predecessors or progenitors. But that which both the gradationalist and palæontologist want, is a knowledge of the *development* of the types, their life-history, indeed.

Here is the work, this is the labour! Our immediate fathers began it; we have entered into their labours; but our children's children will have their hands full, not for one, but for many generations. Were this done, could we describe in detail the rise and progress of every part, and of every organ in the structure of any form in the genera, families, orders, classes, and sub-kingdoms of the animal kingdom; we might then come to some conclusion as to the relations of these various forms, and make some safe guesses as to how they have arisen. Nevertheless, if we cannot do all, that is no reason why we should do nothing, and stand as men who cannot find their hands; the light is breaking in upon us already; albeit, the work has but just been begun. The relations of living forms to each other—even in the adults—and the relations of extinct to living types; these flowers of science are opening and displaying their beauties to patient observers. We are now not merely considering the relations of the various vertebrate classes to each other, or of the various articulate, or molluscous, or radiated classes, within their own special circle; but embryology is leading us to the origin, as it were, of each great primary group, and of the branching off, so to speak, of each great group from some common stock.

However admirable in form and action *man* now is, he will soon, as a *vertebrate*, be ready to call the worm his sister and his mother; for his group is being set side by side with the worm-group—with the living forms from which sprang the "poor beetle," and the labouring ant. Indeed, as seven cities claimed Homer, so several *invertebrate* stocks now claim to have given birth to the noble *vertebrata*. The noisiest claimants are the *worm* and the *ascidian*—that poor relation of the oyster; by some this is thought to be madness, but there is method in it. I will now quote part of an article which appeared in the *Nineteenth Century* for December last, on "Recent Science." The writer is giving an account of Prof. Reichenbach's beautiful researches into the embryology of the common freshwater cray-fish, and then he goes on to compare the development of the nervous axis both in the invertebrata and vertebrata.

"Until quite recently the manner in which the central nervous system arises has always been considered as one of the most important distinctions between vertebrate and invertebrate animals. In the former, at the period when the embryo is a small three-layered patch on the surface of the egg, a longitudinal groove appears, the side walls of which, meeting above, inclose a tube lined by the epiblast. From the epiblastic cells thus shut off, the whole brain and spinal cord are produced, together with the roots of the cranial and spinal nerves, as the recent observations of Mr. Balfour [1] and Dr. Marshall [2] have shown. In the invertebrata, on the other hand, it was always supposed that the nerve-cord was produced from the middle layer of the embryo, or mesoblast; but this has been shown not to be the case, for it has now been proved that, in many of these, the nervous system arises from a thickening of epiblast, which only differs from the corresponding structure in vertebrata by the fact that it is not sunk in a groove. But the relation, in this respect, of the two great groups of the animal kingdom has never been more clearly brought out than in Reichenbach's [3] paper. He shows not only that the nerve-cord is a product of the epiblast, but that it arises from the cells lining an actual

[1] "On the Development of the Fresh-water Crayfish." (Die Embryonanlage und erste Entwickelung des Flusskrebses.") *Zeitscrift für wiss. Zool.* xxix., Bd. 2, Heft, July, 1877.
[2] *Phil. Trans.*, vol. clxvi., and *Journ. of Anat.*, April, 1877.
[3] *Journ. of Anat. and Phys.*, April, 1877.

groove—a groove having precisely the same relations, and in one part of its course being nearly as deep, as the 'medullary groove' of a chick or a tadpole. He also shows that the eyes are formed not, as is usually stated, as elevations, but as depressions in the epiblast; the cells lining these depressions becoming connected with those of the first ganglion of the nerve-cord. Here again is a remarkable resemblance to vertebrates, in which the organs of the higher senses always originate as involutions of the surface-layer" (page 896).

I have thus passed insensibly from the meaning to the aims of morphology. I trust you will agree with me that it is "a topmost fruitful bough" of the great tree of modern science; it is certainly fuller of buds than of flowers, for now is its early spring only. Kindly attend whilst I open a bud or two to show you what the flowers promise to be.

The ends and aims of *morphology* are different from those of *physiology; histology* may be said to be equally related to each and ancillary to both. The study of one branch seems to ask in its workers for an innate fitness for the one rather than for the other. One man sharply questions the *why* of nature; the other patiently searches after the *how*. *Morphology* asks for one who can work and wait in silence year after year; and his qualities have need to be those of quick insight, combined with the most phlegmatic laboriousness. Here, in this case, *natural* qualifications are of more importance than those which can be acquired. But the physiologist sharply asking *why* needs to be trained for his work; he must be a mathematician and a chemist as well as an anatomist; ready action and cunning inventiveness are most needed in him; a seeing eye, a copying hand, and a somewhat imaginative nature; these are the qualifications asked for in the morphologist. Delight in living forms and their transformations shows itself very early in us all; morphology is *æsthetic* before it is *scientific;* it becomes *scientific* as soon as it is *comparative*. The morphologist is nothing if not comparative; the development of accurate observation, combined with ready and constant comparison and unconscious classification—these are the necessary elements in the morphological worker.

The group of animals to which we belong—the vertebrata—considered as to their skeletal morphology, form alone a wide field; "there is yet much land to be possessed." In that division of a subdivided science I have chosen for time and for work's sake mainly the head; for in it are to be found the most intricate interweavings, the hardest knots of nature. For a time, for work's sake, one kind of head is enough; if all the parts are to be considered in their origin and relations, in their changes and development. For the solid and supporting parts of the *building*, so to speak, are to no purpose, have no meaning, if we could possibly forget their contents and their outgoing and overlying parts.

Considering the great complexity of structure in the highest types, the mind casts about to see if there be no similar forms of living creatures in which the structural problems are simpler. As man does not stand alone, but is merely—in respect of his lower nature—one of a large series of living forms, something, surely, may be learned of him, collaterally, and from below, by seeking what may be seen in the types that come nearest to him. Feeling our way down among the branches of the great vertebrate life-tree, we come to forms somewhat simpler, indeed, but formed on the whole on the same pattern, and having on the whole the same mode of embryogeny, and no real break occurs, even among living types, until we have passed the lamprey and his companions. Searching downwards, however, from any culminating type of mammal, we shall come to no form directly underlying them until we are among aquatic creatures; the birds, lying over the reptiles, belong to another "leader" in the life-tree.

Do but consider what a manufactory, what a laboratory, what a temple (if I may so speak) the head is! Yet it and all the body, of which it is the chief part, is developed vegetatively—its *growth* is as the growth of a plant, but its *architecture* stains the pride of all the glory of human skill. Man, not *structurally* only, but *socially*, also, is both husbandry and a building. And as the forces that bind the units of society together are the same as those that perfect the individual as such; so, also, is it in that which enclothes man and brings him into conscious relation to his fellows. The forces that work in the elementary parts are the same as those that work in the whole to make it one whole. The body is compacted together by that which every cell, every tissue, and every organ supplies; "according to the effectual working in the measure of every part" does it live, grow, and build up itself, and perform its wondrous and inimitable functions.

For a century past the thinking mind has been gradually trained to consider the earth, which is our temporary home, as a *development*, as being in a state now very different from that which it had at first, as having undergone, not one, but a thousand changes. Every one, now, knows that the earth did not "rise like an exhalation," and immediately assume its present form, wear its present robes, carry its present living forms; but that, during *Eonian days*—immeasurable secular periods—the face of the earth has changed as much as the face of a man changes during the "seven ages of his eventful history." It will take some time to bring the mind face to face with *our* facts; the thinkers as well as the unthinking will be slow in parting with the old cherished idea of the sudden apparition of a perfect man upon the earth, and the more because this *seems* to be the teaching of the most venerable records of history; which, indeed, ought to be *sacred* to us, if for no other reason than their undoubted antiquity. Those most venerable records have not suffered now that we get a Pisgah-view of the earth's development; they will not suffer from any doctrine of the slow development of man.

I had to speak of the *aims* of morphology; its highest aims are to be able to read off the archaic writings in which the members of man were in olden times written; to decipher the first promise and prophecy of his organic life in its initial letters up to the characters that express the form of the jointed worm, and to see the form of the jointed worm exalted into the fulness of the form of man. Yet we know of nothing but the sequences and results of the morphological force; we know absolutely as much of the nature of the human soul as of the nature of protoplasm, and nothing of either. The morphologist, as such, for the time, is like Gallio, he "careth for none of these things;" he refuses to be hindered with side-questions, however grave and important; his motto is, "this one thing I do." His work is to trace the *germ* into the *adult* or *germ-grower;* to scale every stage and step of a living creature's life; to map out each form, passing into succeeding forms, until the perfect form appears.

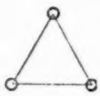
The ladder of man's life reaches up to the highest heaven of organic beauty; that of the horse, the ox, and the lion stops far short of this height; yet are they all perfect after their kind. You will see at once that man is an animal *plus* something that has made it possible for him to become "in form and moving so express and admirable; the beauty of the world, the paragon of animals!" Prof. Flower will show you what a poor thing man is when that which makes him *man* is arrested or suppressed; you will then "look on this picture and on this," on man in his highest development; his outward form corresponding to the power and excellence within; and on man undeveloped, brutal, foul in face, and fouler still in life.

W. K. PARKER

FLOATING MAGNETS

THE publication of my experiments on "Floating Magnets," in the *American Journal of Science* and in NATURE, was made merely as a claim to this new method of experimenting. I now send you the law of the morphology of their configurations, and show how these experiments illustrate the phenomena of allotropy,


2a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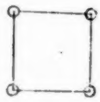
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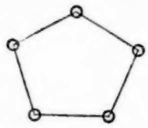
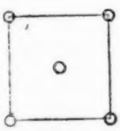

5a

isomerism, expansion or solidification of water, bismuth antimony, &c., the atomic hypothesis, and the kinetic theory of gases.

The configurations of the floating magnets given in this paper are reduced to half-size. They were obtained as follows:—A cylindrical magnet, 387 millimetres long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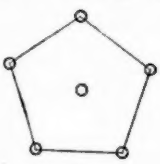
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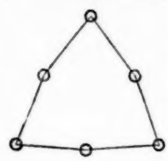
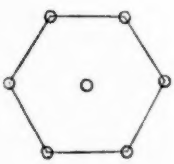

6b

and thirteen millimetres in diameter, was clamped with its lower end sixty millimetres above the plane in which were the ends of the floating magnets.

After each configuration was formed the tips of the needles were dotted with printer's ink, and a flat piece of cardboard was carefully lowered on to the configura-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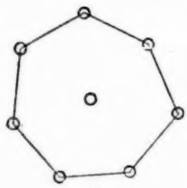
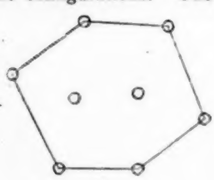

8a

tion, which was thus printed on the card. The points formed in this way were placed on drawing-paper, and the imprinted points were pierced with a needle. Thus the centres of the magnets were located, and around these points were drawn the circles of the element of the configurations. The configurations here given are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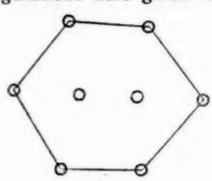
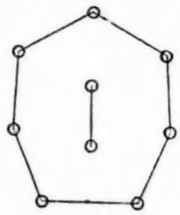

8c

one-half the size of the prints taken from nature, "with all their imperfections on their heads," produced by the unavoidable unequal magnetization of the component needles.

These configurations are numbered from 2 up to 18 *b*; the numbers indicating the numbers of floating magnets in the configurations. Where *a*, *b*, and *c* occur under a configuration they show the order of their stability. Thus 5 *a* is more stable than 5 *b* and 6 *a* than 6 *b*.

The law of the morphology of these forms is as follows:—They are divided into primaries, secondaries, tertiaries, &c. The primary configurations are from 2 up to 9 *a*.

The secondaries begin with 9 (one might even say with *b* and *c* of 8). These secondary configurations have the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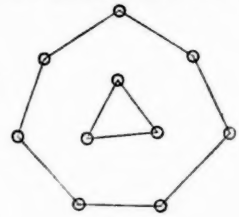
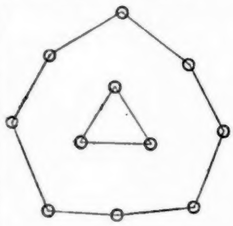

10

stable primaries for *nuclei*. Thus configurations 9, 10, 11, 12, 13, 14, 15, 16, 17, 18*a*, and 18*b*, have respectively 2, 3, 3, 4, 4, 5 (flattened), 6*a* (which is "5 flattened" expanded to a regular pentagon), 7, *pointed* (*compressed?*) towards a vertex of the hexagon, 7, 7, 8.

Nineteen needles form the first configuration of the tertiaries. This is formed of 9 as nucleus, surrounded by 10 floating magnets.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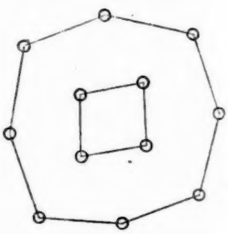
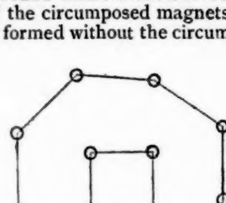

12

Twenty has 9 for nucleus, with 11 circumposed; but this form is unstable, and soon changes into Fig. 20, which has 10 magnets for nucleus with 10 circumposed. This is the only instance (except the flattened pentagon, Fig. 14) I have found where a nucleus is changed in form by the action of the circumposed magnets. This nucleus of 20 cannot be formed without the circumposed magnets, as in Fig. 20.


13

Twenty-two has 11 for nucleus, surrounded with 11 magnets.

Twenty-three has 11 for nucleus, with 12 circumposed needles, arranged parallel to nucleus.

Twenty-four is formed of 11 for nucleus, surrounded with 12, and *one* opposite the base of ∴.

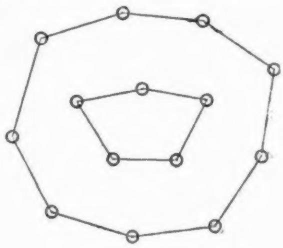
Twenty-five is formed of 13 for nucleus, with 12 circumposed, and parallel to nucleus.

Twenty-six is formed of 14 for nucleus, with 12 magnets circumposed.

Twenty-seven is formed of 15 for nucleus, with 13 magnets circumposed.

Twenty-eight is formed of 14 for nucleus with 13 circumposed.

Twenty-nine is formed of 16 for nucleus, with 13 circumscribed.

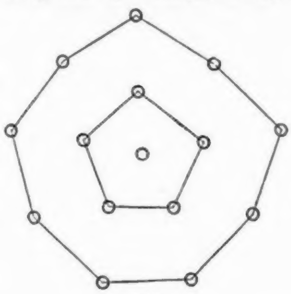


14

Thirty is formed of 17 for nucleus, with 13 circumscribed.

Thirty-one is formed of 18 for nucleus, with 13 circumscribed.

Thirty-two begins the *Quaternary Configurations*, for it is formed of 19, with 13 circumposed magnets.

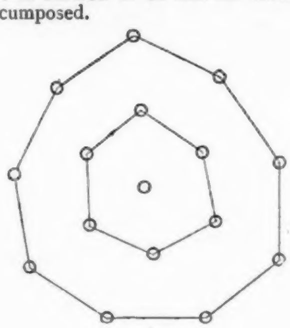


15

Thirty-three is formed of 20 for nucleus, with 13 magnets circumposed.

Thirty-four is formed of 21 for nucleus, with 13 magnets circumposed.

Thirty-five is formed of 22 feet for nucleus, with 13 magnets circumposed.



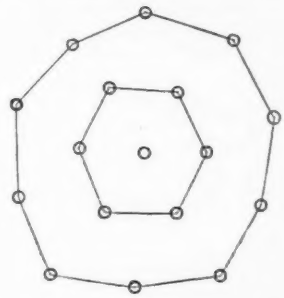
16

Thirty-six is formed of 23 for nucleus, with 13 magnets circumposed.

Thirty-seven is formed of 24 for nucleus, with 13 circumscribed magnets.

Thirty-eight is formed of 26 with 12 magnets circumscribed.

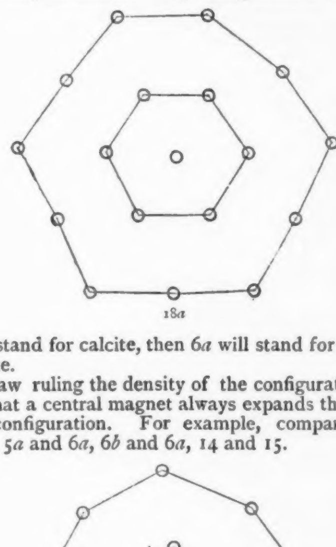
The expansion of liquids, like ice and antimony, on solidification, allotropy and isomerism, are illustrated by the fact that different configurations formed of the same number of atoms have densities inversely as their areas.



17

Thus 5*b* is about $\frac{1}{10}$th greater in area than 5*a*. So if 5*a* represent water at 0° C., 5*b* may stand for ice at 0° C.

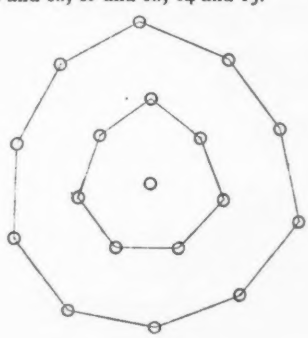
Similarly in allotropy if 6*a* stand for graphite, then 6*b* may stand for diamond, and the three forms of titanic oxide, rutile, brookite, and anatase, and their different densities may be illustrated by configurations 1*a*, 8*b*, 8*c*.



18*a*

If 6*b* stand for calcite, then 6*a* will stand for its isomer anagonite.

The law ruling the density of the configuration is evidently that a central magnet always expands the contours of the configuration. For example, compare Figs. 4 and 5*b*, 5*a* and 6*a*, 6*b* and 6*a*, 14 and 15.

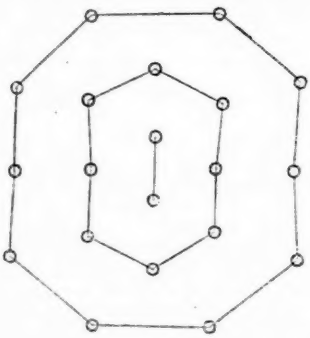


18*b*

These configurations—at least the stable ones—can be obtained by *suspending* the magnets by fine silk fibres. I have thus obtained all the stable forms; and the plan proposed to me by my friend Prof. Rood will no doubt give these configurations. He proposed to me to suspend

gilt pith balls by silk fibres and then electrify them with the same electricity.

If *suspended* configurations be brought near each other we will cause the vibrations of their component magnets (atoms), and thus we may illustrate the atomic vibrations in molecules. If a suspended configuration be brought in contact with a piece of paper, supported vertically, the interaction of the suspended magnet may force it from the



20

vertical, and cause it to fall, and thus may be illustrated the molecular pressure of gases.

I will here point out the stable and unstable configurations. $5a$ is more stable than $5b$, and $6a$ is more stable than $6b$. The latter is sent into $6a$ on vibrating it. $8c$ is very unstable (like . : .), and goes into $8b$ on vibration, caused by elevating and lowering the superposed magnet.

A. M. MAYER

P.S.[1]—As to the configuration . : . it is so *very* unstable that I have not reproduced it in these configurations, for it is really *too unstable* to exist except for *an instant.*

The hexagon only exists with a central magnet. Mr. C. S. Pierce and I have had several discussions about the stability of ⁘. I always have maintained that it was *impossible* to get this form, for a central repellant body was necessary to the tension of the ⁘ which is like a soap bubble *without* cohesion of contiguous elements. Seven magnets form *only* ⁘.

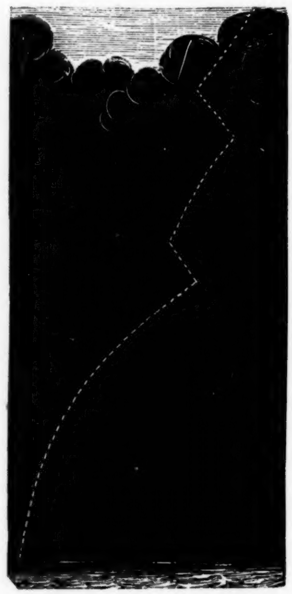
⁘ is more stable than ⁘.

ON A REMARKABLE FLASH OF LIGHTNING[2]

ON the evening of August 16 last year (1877) a heavy thunderstorm took place in this vicinity (Southport). It was preceded by a fall of the barometer not exceding one-tenth of an inch, the wind at 1 o'clock P.M. being west, backing gradually until at 9 o'clock P.M. it was south. At the time of the storm to which my present observations refer it was south-west, and consequently its direction was nearly parallel with the coast line.

I was standing at the shore-end of Leicester Street, watching the approach of the storm, and observing the progress and direction of the more important flashes, when about 8 o'clock a vivid flash of lightning fell apparently into the channel (the water being not much above low water mark of a neap tide) about one-sixth of a mile north of the end of the pier. In about a minute afterwards another fell about one-sixth of a mile north-east of the previous one, and after a similar interval a third stream of electricity descended about another one-sixth of a mile in the same direction. The first and third flashes were of the usual character of forked lightning, but the second presented an appearance which I do not recollect to have witnessed before. From its exit from the clouds to its fall into the sea it seemed composed of small detached fragments which caused it to assume the aspect depicted below.

On the following day, in the course of a conversation respecting the storm of the previous evening, I mentioned the phenomenon to Mr. Thistlethwaite, who informed me that he had been particularly struck by the extraordinary



appearance of this singular flash, which he had observed whilst sitting in the "parsonage" (the house adjoining the south-west side of the Manchester and Liverpool District Bank), and which to him appeared exactly as I have depicted it. This gentleman could, however, have seen the upper portion of the flash only, as the houses in Lord Street and on the Promenade intervened between his point of observation and the shore.

Heavy rain seemed to follow in the wake of the third flash, and came on with a noise like that of a great rush of wind, but as the direction of the storm was nearly coincident with the water-line, inclining but slightly towards the beach, about ten minutes elapsed before the downfall reached the place where I stood.

From the information I afterwards obtained the thunderstorm was subsequently, a few miles to the north-east of Southport, more severe than it was in Southport itself.

Southport, March 11 B. ST. J. B. JOULE

[1] Addressed to Sir Wm. Thomson.
[2] Paper by B. St. J. B. Joule, at the Lit. and Phil. Soc., Manchester.

OUR ASTRONOMICAL COLUMN

CACCIATORE'S SUPPOSED PLANET OF 1835.—It might have been expected that long ere this, if the object twice observed at Palermo in May, 1835, were really a planet, it would have been recovered by one or other of the astronomers who have occupied themselves with the examination of the ecliptical region of the sky.

The particulars of the Palermo observations were communicated by Cacciatore to Valz in a letter dated September 19, 1836, and at an earlier period to the late Admiral Smyth, as will be known to readers of the "Cycle of Celestial Objects." Valz sent a copy of Cacciatore's letter to Schumacher, who published it in No. 600 of the *Astronomische Nachrichten*. When observing the star 503 of Mayer's catalogue with the Ramsden circle, on May 11, 1835, it was noted down that a smaller star of the eighth magnitude followed Mayer's star two seconds of time, and was about 2½′ to the south. Such entries were frequently made by Piazzi, when observing with the same instrument, as may be seen from his catalogue, but although No. 503 occurs there, no mention is made of a star near it. On the next fine night, May 14, observing Mayer's star again, the assistant, according to custom, read out the note made on May 11: "Seguita da una altra di 8 per 2″ circa di A.R. circa 2½′ al sud." No star was then visible in this position even in a dark field, but one of the eighth magnitude *preceded* Mayer's star nine seconds of time, only 1½′ to the south. Cacciatore says he intended to repeat the observation on the following evening, the weather promising to continue fine. Returning to the library he found that no one of the four small planets known at that time was in the observed position, and he appears to have considered the object either a planet beyond Uranus or a comet, remarking: "Onde con impazienza attendeva il dimani." But the night of May 15 proved unfavourable, rain setting in, followed by clouded skies for upwards of a fortnight, and not until June 2 could an observation be attempted, "Ma la stella era involta nel crepuscolo feci varj tentativi fuori del méridiano, non transcurai ogni mezzo per riconoscere la mia osservazione." Cacciatore says his assistants were unsuccessful on other evenings to the end of June. The search was repeated in the first five months of 1836, but to no purpose.

Valz first showed that a body with the observed positions on May 11 and 14, could not be a distant planet, as Cacciatore had conjectured, but rather a pretty near member of the minor-planet group, which, on the hypothesis of a circular orbit, might have a period of revolution of about three years, with the ascending node of the orbit in longitude 339° 36′ and an inclination of 3° 22′ to the plane of the ecliptic. In 1849 Dr. Luther repeated the calculation with the following results:—Radius of orbit, 2·1055; ascending node, 343° 20′; inclination, 3° 37′; period, 1,116 days; and from these elements Oeltzen computed a *zodiac* for the planet, or a table indicating with right ascension as argument, the northern and southern limits of declination (*Astron. Nach.*, No. 662). It is certain that any determination of the position of the orbit from Cacciatore's data must be open to considerable uncertainty, and hence a search for his supposed planet amongst the one hundred and eighty-eight planets now discovered would not be decisive one way or the other if confined to similarity in the position of the nodes and the inclination; places must be calculated for the epoch of Cacciatore's observation for such planets as could by possibility pass near Mayer's star. An attempt in this direction has failed to identify the object. That a minor planet which so far from opposition attains the brightness of stars of the eighth magnitude can still remain unknown to us is, to say the least, very improbable. Must we leave Cacciatore's star in the same category as those reported to have been observed by Huth in 1801 and Reissig in 1803, to which reference has been made in this column?

THE TOTAL SOLAR ECLIPSE OF 1883, MAY 6.—In continuation of our notices of the total eclipses of the sun during the remainder of the present century, we present the elements of the eclipse of May 6, 1883:—

G.M.T. of conjunction in R.A., May 6, at 9h. 44m. 42s.

	°	′	″	
R.A.	43	30	52·2	
Moon's hourly motion in R.A.		38	22·6	
Sun's ,, ,, ...		2	25·0	
Moon's declination	16	11	32·2	N.
Sun's ,, ...	16	37	52·5	N.
Moon's hourly motion in declination ...		7	26·2	N.
Sun's ,, ,, ...		0	41·9	N.
Moon's horizontal parallax		60	52·0	
Sun's ,, ,, ...			8·8	
Moon's true semi-diameter		16	35·2	
Sun's ,, ,, ...		15	51·0	

The central and total eclipse begins in longitude 156° 1′ E., latitude 34° 43′ S., and ends in 86° 44′ W. and 13° 41′ S., and the central eclipse occurs with the sun on the meridian in 147° 4′ W., and 9° 11′ S. The following are also points upon the central line:—

	° ′		° ′			° ′		° ′
Long.	179 51 E.	Lat.	25 43 S.		Long.	137 44 W.	Lat.	6 24 S.
,,	168 19 W.	,,	19 52		,,	119 52 W.	,,	5 51
,,	160 49 W.	,,	15 49		,,	108 12 W.	,,	7 51 S.
,,	140 51 W.	,,	7 7 S.					

The path of the eclipse is almost wholly a sea-track, and the only probable region for obtaining observations of any value will be in the Marquesan longitudes. A direct calculation for the island Fetou-houhou or Chanel Island, with the position of the Admiralty chart, gives for commencement of totality 0h. 42m. 3s. local mean time, and duration of the total phase 2m. 53s. The following are the limits of the zone of totality about the Marquesas group:—

Longitude W.	South limit, Latitude.	North limit, Latitude.
°	° ′	° ′
141	8 11	6 2
140	7 55	5 46
139	7 41	5 31
138	7 25	5 16

NOTES

DR. SCHUSTER, the leader of the English Government Eclipse Expedition to Siam, in 1875, sails in the White Star Line ship *Germanic* to-day to observe the eclipse of the 29th instant. Prof. Thorpe, F.R.S., accompanies him on the same errand, and will make magnetic observations over a great portion of his route. Mr. Norman Lockyer intends to sail in the *Baltic* on the 9th instant. We learn that the appropriation made by the American Government are so small that, in strange contrast to what has happened in the case of all English Expeditions since 1870, no facilities can be offered officially to observers from other countries. Still we doubt not that they will receive both welcome and aid from their *confrères*.

CAPT. MOUCHEZ has been appointed Director of the Paris Observatory. A sub-director has also been appointed, but contradictory reports have reached us as to who has been selected.

A LARGE number of foreign men of science have promised to be present at the Dublin meeting of the British Association; among the names mentioned at the last meeting of the local committee are Professors Sachs, Würzburg; C. Pierce, New York; S. H. Scudder, Cambridge, Mass.; A. S. Packard, Salem, Mass.; and Karl Koch, Berlin. The programme of excursions will be finally settled at the next meeting of the committee. Visits to almost every place of interest within easy distance of the city will be arranged for, and the

usually vexing questions of locomotion and commissariat carefully attended to. The gentlemen of the Excursion Committee are sparing neither time nor trouble to work out the exceedingly difficult task they have undertaken in a thoroughly satisfactory manner. A report from Professors M'Nab and Macalister, editors of the "Guide Book," was read, and shows that the little volume will be a most interesting one. It will consist of sixteen parts, embracing every subject of scientific interest, and will have the following maps :—The six-inch map of the City of Dublin, the ten mile to the inch map of the province of Leinster, and a geologically coloured map of the country, on a scale of a quarter of an inch to the mile. The maps are being prepared under the direction of Major Wilkinson, chief of the Ordnance Survey in Ireland.

AMONG the excursions arranged for in connection with the approaching Paris meeting of the French Association are the following: On August 24, to Fécamp and Etretat; 28th to Tancarville Château, the Roman remains at Lillebonne, and the manufactures of Bolbec; on the 31st to Rouen, returning by steamer to Paris.

THE following is a list of the scientific conferences still to be held in connection with the Paris Exhibition :—Demography, July 5-9; Ethnography, July 15-17; Means of Transport, July 22-27; Hygiene, August 1-10; Civil Engineering, August 5-14; Anthropology, August 15-21; Commerce and Industry, August 16-22; Meteorology, August 24-28; Geology, September 2-4.

THE distribution of the medals of the Paris Geographical Society at the Sorbonne on Friday was witnessed by an immense crowd which had gathered to hear Mr. Stanley, who was received with tremendous enthusiasm. His address, in which he carefully expounded the state of African exploration when he began his work, was delivered in English, and a translation read in French by M. Maunoir, the general secretary of the Society. The meeting was presided over by Admiral La Roncière le Noury, who spoke in English when he handed over the gold medal to the great African explorer. Stanley returned thanks in English. These two addresses were not translated as it became evident a large number of the audience understood the proceedings. The other medals to M. Vivien De St. Martin and Dr. Harmand were then delivered.

AT the Paris *fête* of June 30 the part played by electricity was smaller than anticipated. The number of electric lamps was large, but the effect not particularly good. The Jablokhoff candles, although superior to gas-lamps, were not sufficient to overcome all the mass of light which surrounded them. A large number of Bunsen elements had been put into requisition, but the regulators were wanting in regularity, and much of the effect was consequently lost. Competent persons say that the result would not have been so poor if previous successes had not raised too ambitious expectations in the public and too much confidence in the operator.

THE position in the physical section of the French Academy of Sciences, rendered vacant by the death of Becquerel in January last, has been filled by the election of M. A. Cornu. The recipient of this honour is best known by his investigations into such fundamenta as the density of the earth and the velocity of light. Among his other researches of more recent date we might mention those "On the Experimental Determination of the Principal Elements in an Optical System," and "On the Optical Polarisation due to the Reflexion on the Surface of Transparent Bodies." M. Lecoq de Boisbaudran has been elected a Corresponding Member in place of the late M. Malaguti.

PROF. A. W. HOFMANN, of Berlin, has passed through a severe attack of fever during the past month, and, although now out of danger, will be for some time unable to fulfil the active duties of his position. A handsome *brochure* has lately appeared, commemorating the grand *commers* given in honour of his sixtieth birthday, by the students of Berlin, last March.

AT the general meeting of the Scottish Meteorological Society to-morrow Dr. Mitchell and Mr. Buchan will read a paper comparing the weather and health of New York with London; and Mr. Buchan another on the influence of the physical configuration on the seasonal distribution of the Scottish rainfall.

MR. EDWYN C. REED, well known to many English zoologists from the collections he has from time to time forwarded from Chile, and author of several papers on the entomology of that country, has left his post in the Museum of Santiago and accepted the appointment of Professor of Zoology in the "Liceo" of Valparaiso, and Director of its Museum. Mr. Reed sends us copies of two papers which he has recently published at Santiago, one on the Diurnal Lepidoptera of Chile, the other on the Mammals and Birds of the hacienda of Cauquenes, in the province of Colchagua. Both of these deserve the attention of European naturalists.

THE completion of Giffard's large captive balloon has been postponed owing to the bad weather which prevailed in Paris during the greater part of June, but the recent fine weather has enabled the works to be resumed and the balloon will be completed in a few days. On the occasion of the *fête* of June 30, a balloon of 17,000 cubic feet was sent up with two aeronauts. It was filled in forty minutes with hydrogen gas generated with M. Giffard's continuous apparatus, which contrivance is in perfect order, and will be used this week to fill, in about two days, the monster of 25,000 cubic feet.

THE Birmingham Natural History and Microscopical Society have decided to have this year again a marine excursion to Arran. Facilities will be afforded both for dredging excursions in Lamlash and Brodick Bays and elsewhere in the vicinity; and for land excursions to investigate the botany and highly interesting geology of the island. During the summer season a most interesting series of observations may be made on the microscopic larval forms of marine life (hydroids, echinoderms, crustaceans, annelids, &c.) which abound in the sea, and may at this time readily be taken by the tow net. The late season of the year when the previous excursions have been made precluded much attention to this most interesting branch of marine zoology, which will be specially studied on this occasion. Should a sufficient number join the excursion it is hoped that a small steamer may be chartered, which will economise time and add to personal comfort. The time for the excursion will be from about the 19th to the 27th of July, but the days will be positively fixed at a meeting of those who are desirous of joining the excursion. The expense will be very moderate, and the Birmingham Society deserve every credit for their enterprise.

THE committee who are charged with the arrangements for the celebration of the fiftieth anniversary of the opening of University College desire to make known that ladies will be admitted to the festival on the same terms as gentlemen. Many ladies have already obtained tickets, and others, who may desire to do so, will find full particulars in the advertisement now appearing in our columns. Among those who have accepted the invitation of the committee are the Earl and Countess of Granville, the Earl of Derby, the Earl of Northbrook, the Earl Fortescue, Lord and Lady Ebury, Lady Belper, Mr. and Mrs. Goschen, Sir John and Lady Lubbock, &c., &c.

"THE aforesaid Martin was one of those unfortunates who were at that time of day (and are, I fear, still) quite out of their places at a public school. If we knew how to use our boys, Martin would have been seized upon and educated as a natural

philosopher." So writes "Tom Brown." Our thoughts reverted to the above description whilst considering the contents of some recent numbers of the *University College School Magazine*. Our present purpose is not to give an account of this Magazine, which, we remark, appears at uncertain intervals, and contains articles of like character with those found in most similar school publications. Bur we desire to draw attention to the formation of a "scientific society" amongst the boys themselves. This was started in January, 1876. At first the members read quasi-original papers once a week, and then a discussion took place upon the same; in May of the present year it was resolved to have papers twice a week. At the outset a library was started, books being presented by the members, and in the Michaelmas term of 1877 a reading-room was opened for use between morning and afternoon school, four days in the week. Amongst the scientific papers taken in, we notice that NATURE heads the list. In the present year a museum has been started, and we give particulars, as doubtless some old U.C.S. boy may be able to add to it for "auld lang syne." It contains a collection of minerals, fossils, metals, &c.; specimens illustrative of economic botany; ethnological implements, weapons, coins, &c.; osteological specimens; marine shells; a Tennant's geological box (200 specimens); and a case of British birds' eggs. The working staff is composed partly of the boys and the terminal subscription is a shilling. The privilege of membership (subject to a ballot) is restricted to the fourth and higher science classes. It will be seen that it is yet the "day of small things" with the Society, but we predict for it considerable usefulness. Had such a society existed at Rugby in the days of "Martin," each would have been made for the other. Papers have been read on "Carbon Dioxide as a Motive Power," "Voltaic Electricity," "Frictional Electricity," "Electro-Magnetism," "Cyclones," the Barometer, the Thermometer, Comets, Coral, &c. The Society fosters study further by offering to its members every year three prizes, awarded at the annual distribution, for the best collection of natural objects and of microscopical objects, and for the best model of any scientific instrument—all these to be made or mounted by the exhibitor. We believe the usefulness of the Society might still further be increased could its council induce leading scientific men to deliver lectures which should be open to the friends of members and of the boys generally. We are sure the present head and vice-masters would lend their countenance to such a proceeding.

FRANCE was visited by an earthquake on June 25, which was felt at Lyons, Mâcon, Valence, Villefranche, and Châlons, The movement was from the east towards the west. The shock lasted half a minute, but caused no damage.

PROF. BURDON SANDERSON delivered the Harveian oration on June 26. He occupied himself with the researches by which, in the first half of the present century, the Harveian doctrine of the working of the circulatory apparatus was developed.

A FINE colossal bronze statue of Capt. Cook, by Mr. Woolner, R.A., which is at present placed in the open space between the United Service Club and the Athenæum, is intended for erection at Sydney, New South Wales.

THE Council of the Sanitary Institute of Great Britain have appointed a committee, consisting of His Grace the Duke of Northumberland, president, Mr. Edwin Chadwick, C.B., Dr. Richardson, F.R.S., and Dr. Lory Marsh, to represent the Sanitary Institute at the Congrès International d'Hygiène in Paris, from the 1st to the 10th of August next. During the congress in Paris the Société Française d'Hygiène, with which the Sanitary Institute is affiliated, will entertain at a banquet on August 9 the members of the Sanitary Institute and their other foreign associates.

WE have received from the Imperial College of Engineering, Tokei, Japan, the Calendar for Session 1877-8, and the reports of the professors for the period 1873-77. We have already referred to this admirably conducted institution so fully already (vol. xvi. p. 44), that we need only say now that these publications confirm all we have said about the college. It is based on the best continental models, and the course of instruction is so complete, thorough, scientific, and practical, that English engineering students who read the syllabus of instruction, the list of contents of the museum, the catalogue of the admirable library, and the professors' reports, will be inclined to wish that Japan were a little nearer home. The enthusiasm and discrimination which the Japanese have shown in adopting all the best characteristics of European civilisation and learning, are one of the wonders of the age; they have been specially fortunate in obtaining as principal of their Engineering College, so intelligent and accomplished a man as Mr. Henry Dyer has shown himself to be. Among the professors are Messrs. J. Perry and W. E. Ayrton, whose names must be known to many of our readers as the authors of valuable original papers in physics, sent by them occasionally to this journal and to the scientific societies.

MR. CONSUL LAYARD, of Noumea, sends to the *Colonies* particulars of extraordinary volcanic eruptions at the island of Tanna in the beginning of the year. The first eruption took place on January 10 last, about 10 A.M. The bottom of the harbour at the west side rose above water for about fifty fathoms length at the first earthquake shock. A new volcano burst out close to "Sulphur Bay," between it and the old volcano. The west side of Port Resolution was all bursting up with steam. A second great eruption and earthquake took place on February 11, and the bottom of the harbour was again upheaved for about another fifty fathoms, making the entrance of the harbour very narrow. Three rocks rose up about a cable's length from the west point to seaward out of eleven fathoms water. There is now a bar with only fifteen feet of water, where there used to be five or five and a half fathoms, right across the mouth of the harbour, a little inside. A tidal wave about fifty feet high swept the east point of the harbour, destroying all the native plantations. The wave occurred on both occasions, but the first was the biggest. The old mountain was very active, roaring and throwing up huge rocks. The tidal wave was very local; so was the shock. The missionary on the other side of the island hardly felt it, and there was no wave there. The natives say they never knew anything like it before. On the west side the earth has cracked and sunk very considerably; on the east side the land was swept by the tidal wave; the plantations on both sides are destroyed.

THE glaciers of the Western Himalayas, according to measurements recently given in the *Tour de Monde*, far surpass in extent any hitherto examined outside of the polar regions. In the Mustagh range, two glaciers immediately adjoining one another possess a united length of sixty-five miles. Another glacier in the neighbourhood is twenty-one miles in length, and from one to two miles in width. Its upper portion is at a height of 24,000 feet above the level of the sea, and its lower portion terminating in masses of ice 250 feet in height, and three miles in breadth, is 16,000 feet above the sea.

SOME interesting fossils have just been found near Holmestrand, on the Bay of Christiania, Norway. They consist of large quantities of dolphin bones and are imbedded in loam some three metres below the present surface, although more than forty-three metres above the level of the sea. Their surroundings are unquestionably of the most recent geological formation, and this discovery may serve as a proof that even during the latest geological period the coast of Southern Norway has risen at least forty-three metres. Not a single fossil of the pliocene or pleistocene has been found.

M. J. S. POLIAKOW, of the Russian Geographical Society, is about to commence his researches in the government of Vladimir and in Lithuania into the remains of the stone period. This expedition is in continuation of the labours of M. Poliakow, commenced more than ten years ago by the discovery of implements of stone in the plane of the river Irkout (1867). Later, in 1871, he found implements of the same kind in the government of Olonets, on the banks of Lakes Lago, Kenozero, &c.; in 1874 he found them also on the banks of the lakes of the upper basin of the Volga; and lastly, the journey which he undertook in 1876, in the valley of the Obi, convinced him not only of the existence of remains of the stone period in Western Siberia, but led him to seek the explanation of many stone implements among the implements of peoples possessing only a low degree of culture, as among the Ostiaks. This series of journeys has enabled M. Poliakow to form a very considerable collection of implements in stone and of curious data on the natural history of that epoch. Now, new discoveries have been made by other travellers in the districts of Mourom, Vladimir, and in Esthonia, on the banks of Lake Bourtnek, where a tumulus has been discovered containing remains of objects connected with cookery. All these discoveries have led M. Paliakow to request the Society to send him into the government of Vladimir and into Esthonia, to study upon the spot these new remains. What attracts the attention of M. Poliakow is that there are, among other things, proofs that, during the stone period, there existed in the small fresh-water lakes a species of seal recalling, by its dimensions and characteristics, the seal of Greenland and the Caspian. Another remarkable fact is the discovery made, along with the instruments of stone in the district of Mourom, remains of the mammoth. After having investigated the materials referred to, M. Poliakow proposes to visit Stockholm, Copenhagen, and other cities, to inspect the pre-historic museums, with a view to complete the materials he possesses for studying the stone period.

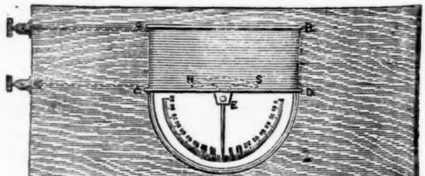
DR. SCHOMBURGK, in his Report on the Botanic Garden and Government Plantations of South Australia for 1877, gives an account of an interesting experiment he made with some Arctic wheat. He received a sample of wheat taken from a quantity left by the American Arctic Expedition ship *Polaris* in 1871, which had been abandoned in north latitude 81° 16′. This wheat had been left on the beach exposed to the snow and a temperature of 72° to 104° of frost for five years, and was found in a heap by Dr. Ninnis, of H.M. ship *Discovery*, on the return of the last Arctic Expedition to England. Dr. Schomburgk received 1,000 grains, of which he sowed about 300. From the 300 grains about sixty germinated. The plants grew healthy and reached to the height of from three to four feet. It is a bearded wheat, and ripened in the commencement of January. The ears contained about thirty grains each, which were but small, though round and plump. The birds unfortunately destroyed the greater part before it came to maturity, but the interesting fact proves the assertion that the grain of the cereals possesses a vitality not surpassed by any other seed.

THE additions to the Zoological Society's Gardens during the past week include a Japanese Wolf (*Canis hodophylax*) from Japan, presented by Mr. H. Heywood Jones; a Rhesus Monkey (*Macacus Erythræus*) from India, presented by Mrs. Walcot; a Brown Capuchin (*Cebus fatuellus*), a Crested Curassow (*Crax alector*) from Venezuela, presented by Mr. A. Warmington; a Mona Monkey (*Cercopithecus mona*) from West Africa, presented by Capt. C. F. Filliter; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mrs. George Yeomens; a Common Marmoset (*Hapale jacchus*) from South East Brazil, a Pinche Monkey (*Midas œdipus*) from New Granada, presented by Mr. Edward Clayton; a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. Allen Forbes; a Short-Tailed Capromy (*Capromys brachyurus*) from Jamaica presented by the Hon. J. Burford Hancock; a Pine Marte, (*Martes abietum*) from Ireland, presented by Mr. Robert Walter; six Goldfinches (*Carduelis elegans*) British Isles, a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. C. F. Johnson; four Cunningham's Skinks (*Egernia cunninghamii*) from Australia, presented by Mr. D. C. Pearson; a Garden's Night Heron (*Nycticorax gardeni*), a Common Boa (*Boa constrictor*) from South America, purchased; a Green-necked Peafowl (*Pavo spicifer*) bred in the Gardens.

A NEW GALVANOMETER FOR LECTURE PURPOSES

ALL who have had the experience of attempting to exhibit to a large audience the simple phenomena of dynamical electricity will bear testimony to the difficulty of rendering apparent over the whole of a lecture-theatre the movements of a galvanometer needle. When the galvanometer lies flat upon the table and the movements of the needle itself, or of the index attached to it are observed, the number of observers must be confined to those near at hand. Even the mirror galvanometer, indispensable as it is for delicate experiments, is open to the objection that a popular audience does not immediately appreciate the significance of the motions of the wandering spot of light. The devices for projecting the moving needle upon the screen have, up to the present time, been so large and inconvenient as to militate against their use for popular demonstration.

These facts led the writer some months ago to attempt to construct an instrument for projection upon the screen that should be within the size of an ordinary magic-lantern slide. The early attempts to do this were unpromising, and possessed little sensitivity even for considerable currents. In the latest form of the instrument, however, this defect has been overcome, and the galvanometer has in several trials before large popular audiences, as well as in the teaching of the lecture-room, shown itself to



answer with complete satisfaction the purposes for which it was designed.

In the most improved form, the galvanometer consists of a mahogany block the size and thickness of an ordinary magic lantern slider, which serves as a frame to contain the working parts. The coil of wire is wound upon a flat bobbin of brass or ivory, its ends being brought to a pair of terminals at the extremity of the slider. Within the coil the magnetised needle is suspended delicately by a horizontal axis between two adjustable screws. Attached at right angles to the needle is a light index of thin brass or of aluminium. The scale, which is transparent, is reduced by photography upon a glass plate. The arrangements are therefore on a small scale like those of a Becquerel's vertical galvanometer inverted. When no current passes, the index arm hangs downward, the centre of gravity being adjusted very little below the centre of suspension so as to secure the greater degree of sensitivity. But to correct for the dip when the plane of the instrument is nearly in the meridian a small compensating magnet may be placed upon the table below. Thus the slightest movement of the needle is at once made visible by the motion of the magnified image of the scale and index; and will be quite apparent even without lowering the lights of the room.

As the instrument may be constructed with either a short-coil or a long-coil, it can be applied to a variety of experimental uses. And its portability and simplicity exceed those of any galvanometer hitherto employed for purposes of demonstration.

SILVANUS P. THOMPSON

EARTHQUAKES ON THE PHILIPPINES IN THE YEAR 1876, ACCORDING TO THE PUBLICATION OF THE "ATENEO MUNICIPAL" IN MANILA. COMMUNICATED BY DR. A. B. MEYER, DRESDEN.

Date.		Hour.	Place.	Province or District.	Island.	Direction.	Remarks.
January	19	1 A.M.	Vigan	Ilocos sur	Luzon	—	—
February	7	4–5 A.M.	Iba	Zambales	,,	—	—
,,	10	7 A.M.	Laoag	Ilocos norte	,,	—	—
March	18	12.15 A.M.	Vigan	Ilocos sur.	,,	—	—
,,	18	11–12 P.M.	Benguet	Benguet	,,	—	—
,,	21	5–6 A.M.	Batangas	Batangas	,,	—	—
,,	31	2.25 P.M.	Laoag	Ilocos norte	,,	N.–S.	—
April	14	2–3 A.M.	Iba	Zambales	,,	—	—
June	12	12.45 A.M.	Nueva-Cáceres	Camarines, S.	,,	—	—
,,	12	11–12 P.M.	Albay	Albay	,,	—	—
,,	18	? A.M.	Laoag	Ilocos norte	,,	N.–S.	—
July	13	10.30 P.M.	Iba	Zambales	,,	—	—
,,	13	,,	Cavite	Cavite	,,	N.–S.	—
,,	13	10–11 P.M.	Bulacan	Bulacan	,,	—	—
,,	13	10.34 P.M.	Manila	Manila	,,	N.N.E.–S.S.W.	Intensity 3°, sismometer 2 mm.
,,	26	? A.M.	Tacloban	—	Leyte	—	Strong.
,,	26	4 A.M.	Surigao	—	Mindanao	E.–W.	—
,,	27	10 A.M.	Baler	Com. P. M. d. Principe	Luzon	N.–S.	—
August	10	5.45 A.M.	Nueva-Cáceres	Camarines, S.	,,	W.–E.	—
,,	21	12–1 A.M.	Iba	Zambales	,,	—	—
,,	22	10–11 P.M.	,,	,,	,,	—	—
,,	23	12.30 A.M.	Vigan	Ilocos, S.	,,	—	—
September	13	10 A.M.	Nueva-Cáceres	Camarines, S.	,,	—	—
,,	15	11.30 P.M.	Surigao	—	Mindanao	W.–E.	—
November	15	7–8 A.M.	Iba	Zambales	Luzon	—	—
,,	17	11.30 P.M.	Vigan	Ilocos, S.	,,	—	—
,,	17	night.	Benguet	Benguet	,,	—	—
,,	17	,,	Cayan	Lepanto	,,	—	—
,,	18	4–5 A.M.	Iba	Zambales	,,	—	—
,,	19	8 P.M.	Mobo	—	Masbate	—	—
,,	22	noon.	,,	—	,,	—	—
,,	26	—	Albay	Albay	Luzon	—	Great eruption of Mount Tacbacon.
,,	27	11.5 P.M.	Manila	Manila	,,	—	One shock, intensity 3 mm.
December	12	4.5 P.M.	,,	,,	,,	N.E.–S.W.	Intensity 1°, sismometer 1 mm.
,,	12	9.45 P.M.	Zamboanga	—	Mindanao	—	—
,,	13	4 P.M.	Baler	Com. P. M. d. Principe	Luzon	N.–S.	—
,,	13	11.45 P.M.	Zamboanga	—	Mindanao	—	—
,,	18	? P.M.	Iba	Zambales	Luzon	—	—
,,	20	4–5 A.M.	Batangas	Batangas	,,	—	—
,,	25	3 A.M.	Calapan	—	Mindoro	N.–S.	—
,,	25	9.23 A.M.	Manila	Manila	Luzon	S.E.–N.W.	Intensity 1°.

If we take, with Dr. von Drasche ("Fragmente zu einer Geologie der Insel Luzon," Vienna, 1878), North Luzon to a little north from 16° N., Central Luzon from there to about 14° 30′ N., and South Luzon on the south of this line, we have 11 earthquakes in North Luzon, 15 in Central Luzon, 8 in South Luzon; and on the islands mentioned—1 on Mindoro, 2 on Masbate, 1 on Leyte, and 4 on Mindanao.

There were recorded in the year 1876, altogether 41 earthquakes on the Philippine Islands.

SOME RESULTS OF THE SUPPOSITION OF THE VISCOSITY OF THE EARTH[1]

SIR W. THOMSON'S investigation of the bodily tides of an elastic sphere has gone far to overthrow the idea of a semi-fluid interior to the earth, yet geologists are so strongly impressed by the fact that enormous masses of rock have been poured out of volcanic vents in the earth's surface, that the belief is not yet extinct that we live on a thin shell over a sea of molten lava. It appeared to the author, therefore, to be of interest to investigate the consequences which would arise from the supposition that the matter constituting the earth is of a viscous or imperfectly elastic nature. In this paper these hypotheses were followed out, and the results were fully as hostile to the idea of any great mobility of the interior of the earth as are those of Sir W. Thomson.

[1] Abstract of a paper on the bodily tides of viscous spheroids, by G. H. Darwin. Read before the Royal Society, May 23.

It is first shown that every problem about the strains of an incompressible elastic solid has its analogue touching the flow of an incompressible viscous fluid, and that the solution of Sir W. Thomson's problem of the bodily tides of an elastic sphere may thus be adapted to give the bodily tides of a viscous spheroid. The state of internal flow of a viscous spheroid is then found, under the joint influence of any external disturbing force and of the mutual gravitation of the parts of the spheroid.

When there is no disturbing force this gives the law of the subsidence of inequalities on the surface of a viscous globe under the influence of simple gravitation; and it is suggested that some light may possibly be thrown thereby on the laws of geological subsidence and upheaval. It appears that inequalities of wide extent will subside much more quickly than wrinkles, as might have been expected from general considerations.

The rate is found at which a rotating spheroid would adjust itself to a new form of equilibrium, when its axis of figure is not coincident with that of rotation; and the law is established which

was assumed in a former paper.[1] The case is next considered where the disturbing force is regularly periodic in time; this is the assumption appropriate for the tidal problem. The forces which act on the spheroid in this case do not form a rigorously equilibrating system; but there is a small couple called into existence, the consideration of which is deferred to a future paper.

It appears that the bodily tide lags, and is less in height than it would be if the spheroid were perfectly fluid; also the ocean tides on such a spheroid are accelerated, and are less in height than they would be on a rigid nucleus.[2]

This theory is then applied to the lunar semi-diurnal and fortnightly tides, and numerical tables of results are given.

A comparison of the numbers given with the viscosity of pitch at near the freezing temperature (as roughly determined by the author) shows how enormously stiff the earth must be to resist the tidally distorting influence of the moon. It may be remarked that pitch at this temperature is hard, apparently solid and brittle; and if the earth was not very far stiffer than pitch, it would comport itself sensibly like a perfect fluid, and there would be no ocean tides at all. It follows, therefore, that no very considerable portion of the interior of the earth can even distantly approach the fluid condition.

This does not, however, seem conclusive against the existence of bodily tides in the earth of the kind here considered; for, under the enormous pressures which must exist in the interior of the earth, even the solidest substances might be induced to flow to some extent like a fluid of great viscosity.

The theory of the bodily tides of an "elastico-viscous" spheroid is next developed. The kind of imperfection of elasticity considered is where the forces requisite to maintain the body in any strained configuration diminish in geometrical progression, as the time increases in arithmetical progression. There are two constants which define the mechanical nature of this sort of solid: first, the coefficient of rigidity, at the instant immediately after the body has been strained; and second, "the modulus of the time of relaxation of rigidity," which is the time in which the force requisite to maintain the body in its strained position has diminished to ·368 of its initial value. The author is not aware that there is any experimental justification for the assumption of such a law; but after considering the various physical objections which may be raised to it, he concluded that the investigation was still of some value.

The laws of flow of such an ideal solid have been given (with some assistance from Prof. Maxwell) by Mr. Butcher,[3] and they are such that the solutions already found might easily be adapted to the new hypothesis. The results of the application to the tidal problem are not quite so simple as in the case of pure viscosity. By a proper choice of the two constants, the solution becomes either that for a purely viscous spheroid or for a purely elastic one. This hypothesis is therefore intermediate between those of pure viscosity and pure elasticity.

Sir William Thomson worked out numerically the bodily tides of elastic spheres with the rigidities of glass and of iron; and tables of results are given for those rigidities, with various times of relaxation of rigidity, for the semi-diurnal and fortnightly tides.

It appears that if the time of relaxation of rigidity is about one-quarter of the tidal period, then the reduction of ocean-tide does not differ much from what it would be if the spheroid were perfectly elastic. The acceleration of high tide still, however, remains considerable; and a like observation may be made in the case of pure viscosity approaching rigidity. This leads the author to think that perhaps one of the most promising ways of detecting such tides in the earth, would be by the determination of the periods of maximum and minimum in a tide of long period in a high latitude.

The second part of the paper contains a dynamical investigation of the ocean tides in an equatorial canal running round a yielding nucleus, and the results are confirmatory of the previous ones.

The author states as the chief practical result of this paper that it is strongly confirmatory of the view that the earth has a very great effective rigidity; but that its chief value is, that it forms a necessary first chapter to the investigation of the precession of viscous and imperfectly elastic spheroids—an investigation which he hopes to complete very shortly.

[1] On the Influence of Geological Changes on the Earth's Axis of Rotation. *Phil. Trans.*, vol. clxvii. Pt. I.

[2] The law is as follows:—If $\frac{v}{2\pi}$ be the frequency of the tide, μ the coefficient of viscosity, g, gravity, a, earth's radius, w, earth's density, and if $\tan \epsilon = \frac{19\mu v}{2gwa}$, the tide of the viscous spheroid is equal in height to the equilibrium tide of a perfectly fluid spheroid multiplied by $\cos \epsilon$, and the tide is retarded by $\frac{\epsilon}{v}$. Also the equilibrium tide of a shallow ocean overlying the nucleus is equal to the like tide on a rigid nucleus multiplied by $\sin \epsilon$, and there is an acceleration of the time of high water equal to $\frac{\pi}{2v} - \frac{\epsilon}{v}$.

[3] *Proc.* Lond. Math. Soc., December 14, 1876, pp. 107–9.

PHYSICAL GEOLOGY[1]

A Geological Proof that the Changes of Climate in past times were not due to changes in the position of the Pole; with an attempt to assign a minor limit to the duration of Geological Time.

IF we examine the localities of the fossil remains of the Arctic regions, and consider carefully their relations to the position of the present North Pole, we find that we can demonstrate that the Pole has not sensibly changed its place during geological periods, and that the hypothesis of a shifting pole (even if permitted by mechanical considerations) is inadmissible to account for changes in geological climates.

We are thus driven to the conclusion that geological climates are due to the combined cooling of the earth and sun; and on comparing the rates of cooling of such a body as the earth with the maximum measured thicknesses of the several strata, we find a remarkable proportion between them, which leads towards the conclusion that the maximum thicknesses of the strata are proportional to the times of their formation; and so I deduce a minor limit of geological time.

Climate of the Parry Islands in the Jurassic Period.—Capt. M'Clintock found in the Parry Islands, on the north coast of America, at Point Wilkie, in Prince Patrick's Island, lat. 76° 20′, tropical shells, and drew the attention of geologists to the difficult task of providing a tropical climate inside the Arctic Circle, to accommodate the habits of the animals that lived there in jurassic times. The tropical fossils found in the Parry Islands were:—

Ammonites M'Clintocki (M'Clintock).
Monotis septentrionalis ,,
Pleurotomaria sp. ,,
Nucula sp. ,,
Ichthyosaurus sp. (vertebræ) (Sir Edward Belcher).[2]
Teleosaurus sp. (vertebræ) (Capt. Sherard Osborne).[3]

The *Teleosaurus* was a reptile closely resembling the gavial of India, which is found nowhere outside the Tropics, and requires warmer water than the alligator of America. The alligator flourishes in the neighbourhood of New Orleans, whose climate is represented by the following figures:—

Mean Monthly Temperature of New Orleans.

	°		°
January	54·8 F.	July	+ 81·6 F.
February	56·4 ,,	August ...	+ 81·2 ,,
March	62·9 ,,	September ...	+ 78·5 ,,
April	69·0 ,,	October ...	− 69·8 ,,
May	74·8 ,,	November ...	− 60·2 ,,
June	79·9 ,,	December ...	− 56·0 ,,

Yearly mean ... ... 68°·7 F.

Reptiles requiring a climate such as is indicated by the preceding table, lived in the jurassic period within 900 miles of the North Pole, where the present climate is represented by the following figures:—

Mean Monthly Temperature of Melville Island.

	°		°
January	− 31·3 F.	July	+ 42·4 F.
February	− 32·4 ,,	August	+ 32·6 ,,
March	− 18·2 ,,	September ...	+ 22·5 ,,
April	− 8·2 ,,	October ...	− 2·8 ,,
May	+ 16·8 ,,	November ...	− 21·1 ,,
June	+ 36·2 ,,	December ...	− 21·6 ,,

Yearly mean ... ... + 1·2 F.

[1] "Notes on Physical Geology." Paper read at the Royal Society, April 4, by the Rev. Samuel Haughton, M.D. Dublin, D.C.L. Oxon, F.R.S., Professor of Geology in the University of Dublin. No. IV.

[2] Exmouth Island, lat. 77° 12′ N. (only 900 miles from the Pole).

[3] Rendezvous Hill, at north-west extremity of Bathurst Island, lat. 77° N.

Climate of Spitzbergen in the Triassic Period.—The Triassic beds of Spitzbergen, lat. 79°, have afforded species of

Nautilus	*Ceratites*
Ammonites	*Halobia*

closely allied to, if not identical with, those of the St. Cassian beds of South Austria.

Climate of Alaska in the Triassic and Jurassic Periods.—In the neighbourhood of Cook's Inlet, in Alaska, lat. 60° N., shells characteristic of the triassic and jurassic periods have been found:—

Monotis	Triassic.[1]
Aucella	Jurassic.
Ammonites Wosnessarski	,,
Ammonites biplex	,,
Belemnites pascillosus	,,
Pleuromya unioides	,,

and similar fossils are found along the Pacific Coast of North America.

It is not possible to explain the occurrence of tropical animals in the three above-mentioned localities, by any change in the position of the earth's axis, even if so great an amount of change as would be required were possible. This statement can be proved as follows:—Let a great circle be drawn, joining Spitzbergen with Cook's Inlet, Alaska; this circle will pass nearly through the North Pole. In order to explain the tropical climate of these two localities, and also of the Parry Islands, the pole must be displaced at right angles to the great circle joining Spitzbergen and Alaska, along the meridian long. 117° E., nearly that of Pekin. The present difference of latitude between New Orleans and Spitzbergen is 45°; so that, in order to make the Arctic regions tropical, we must move the North Pole 45° on the meridian of Pekin, bringing it within 300 miles to the north of that city. Hence it follows that, during the triassic period, Pekin lay under the North Pole, covered by the polar ice-cap. Let us now consider what the South Pole was doing: it had moved on the opposite meridian, and had reached the mouth of the Rio Negro, on the east coast of Patagonia, about 1,000 miles to the south-south-east of Valparaiso and the Chilian Andes. Jurassic strata have been found in the Chilian Andes at 34° S., containing the tropical *Ammonites biplex*, which is found also in Alaska, 60° N., and in Europe. This locality lies within 700 miles of the necessary position of the South Pole, and cannot have enjoyed a tropical climate. The proposed alteration of the North Pole is consistent with the occurrence of tropical animals in the Parry Islands, in Spitzbergen, and in Alaska; while the proposed alteration of the South Pole would permit tropical animals to exist in New Zealand and New Caledonia; but the occurrence of jurassic ammonites within 700 miles of the South Pole is fatal to the proposed shifting of the axis of rotation, even if that were allowable to the extent required.

The Climate of the Arctic Regions during the Tertiary Miocene Period.—There is abundant evidence to show that during the miocene tertiary period the northern parts of the continents of America and Europasia possessed a nearly common forest vegetation, with a temperate climate, resembling that now enjoyed by the northern parts of Italy, such as Lombardy.

The localities in which the *lignite* beds are found, that indicate the former existence of this remarkable vegetation, are the following:—

Greenland (Disco), lat. 70°.
Grinnell Land, lat. 81° 44′.
Spitzbergen (West Coast), lat. 77°.
Alaska and Mackenzie River, lat. 70° to 60°.

The genus *Sequoia* (redwood) has representatives in all these localities, and one Greenland species, *S. gigantea*, is very near the great Californian species which lived in North America in cretaceous times (and still live in California). In Spitzbergen there are found in the miocene beds two species of *Libocedrus*; and of these, one, viz., *L. decurrens*, is now living in California among the Redwoods, while the other still lives in the Andes of Chili. The common *Taxodium* (cypress) of the Southern States occurs fossil in the miocene beds of Spitzbergen, Greenland, and Alaska.[2]

All the genera mentioned in the note are found in Greenland and Spitzbergen, as well as in Alaska; and, according to Prof. Heer, indicate a mean annual temperature of 48° F. during the miocene period in localities where the mean annual temperature is now as low as zero. During the eocene tertiary period, according to Ettingshausen, there flourished a flora in the Tyrol, which indicates a mean annual temperature between 74° F. and 81° F., the species being largely Australian in character. According to the same author the miocene flora of Vienna was sub-tropical, corresponding to a mean annual temperature between 68° F. and 79° F., and closely resembling that of subtropical America. It can be shown by a method similar to that employed for the triassic and jurassic periods, that the North Pole was practically in the same place during the miocene period that it now occupies.

If we join the Mackenzie River and Spitzbergen by the arc of a great circle the North Pole must be moved at right angles to this arc, away from Greenland, through 30°, in order to give all these northern localities a Lombardic climate. The direction in which the pole must be moved is on the meridian of Nagasaki (one of the Japanese Islands), and it reaches a point close to Yakutsk, within 800 miles of the Peninsula of Kamtschatka and the Island of Saghalien, off the Amoor.

Here we meet with a difficulty similar to that offered by the South Pole in the triassic period. The Island of Saghalien and the Peninsula of Kamtschatka contain miocene coal beds, requiring at least a sub-tropical climate, which would be impossible under the supposed circumstances. Also the Islands of Yesso, Nagasaki, and Kiusiu, somewhat farther off, contain similar coal beds.[1]

It is very remarkable that, while there exist so many proofs of a warm climate near the North Pole in former geological periods, there is no evidence from fossils of cooler climates having ever existed in the tropics. It was at one time thought that an exception to this statement occurred in the Island of Java, where, it was asserted, a tertiary flora was to be found, indicating rather a temperate than a tropical climate. The full investigations of Göppert, however, have satisfactorily shown that the tertiary flora of Java is of eocene age, and essentially tropical in character, containing numerous specimens of palms, Musas, peppers, laurels, magnolias, and Proteaceæ.

From all these facts we are entitled to conclude that, down to so recent a period as the miocene tertiary, climates depended chiefly on the internal heat derived from the cooling earth. As we are precluded from assigning large changes in the position of the poles as a cause for large changes of climate, a very interesting question thus arises as to the sense in which we call the miocene tertiary a recent period. This question may be thus discussed:—We may regard the plants and animals preserved in the fossil state in the Arctic regions as self-registering thermometers, recording for us the mean temperature of those regions at successive epochs, marking so many fixed points on the earth's thermometrical scale. In addition to these we have the present temperature of the Arctic regions directly observed, and two other temperatures determined by physical and physiological conditions: these are the temperature of boiling water, and the temperature at which albumen coagulates. No stratified rocks could have been formed on the earth before the first point

[1] Triassic slates, containing *Monotis* and *Halobia*, have been recently discovered in places widely separate from each other, all over the globe, viz.:—New Zealand, New Caledonia, North-West America, Upper India beyond the Himalayas, and in Spitzbergen.

[2] The following genera have been described by Prof. Heer as found at Mackenzie River and Alaska; there are many species of each:—

Planera.	*Juglans* (walnut).
Castanea (chestnut).	*Carya* (hickory).
Diospyros (ebony tree).	*Rhus* (sumach).
Daccinium (bilberry).	*Vitis* (vine).
Acer (maple).	

All these are indicative of a Lombardic climate, for their living representatives (excepting *Vaccinium* and *Acer*) do not extend into the north temperate region.

[1] "Spitzbergen, and the islands of New Siberia, in miocene times, supported a vegetation pointing to like conditions of climate. Further east the coal-fields of Saghalien seem to be likewise of mid-tertiary age, and those of Yesso, I believe, belong to the same epoch. In the Island of Kiusiu miocene rocks are developed to an enormous extent; the volcanic conglomerates, shales, and sandstones of Nagasaki, seem to exceed 5,000 feet in thickness, and the upper portion of this very important series contained, prior to its denudation, one of the richest coal-fields in the world. In the Island of Takosima, where a good section is obtainable, there exist, within a thickness of little more than 300 feet, no less than fourteen beds of coal, varying from 1 to 8 feet thick, and whose united thickness amounts in the aggregate to about 57 feet. Some of them rest on shales containing remains of the old flora, which bears a close resemblance to that of the district at the present day. Unfortunately this rich fossil flora remains as yet undescribed. The fossil flora of Spitzbergen and New Siberia finds its nearest analogue in that of North China and Japan, so that we are compelled to believe in the former extension of a similar flora over the intermediate districts, as well as in the occurrence of very similar conditions of climate."—"The Border Lands of Geology and History" (pp. 28-9). By Thomas W. Kingsmill. Shanghai 1877.

of cooling down was reached, because there was no water to form them; and no life could have existed on the earth until it cooled down to the latter temperature.

Thus we find in the Arctic regions, the following successive temperatures:—

1.—212° F.	... ...	Boiling water.
2.—122° F.	... ...	Coagulation of albumen.
3.— 68° F.	... ...	Triassic and jurassic periods. (Climate of Gulf of Mexico.)
4.— 48° F.	... ...	Miocene tertiary period. (Climate of Lombardy.)
5.— 32° F.	... ...	(Climate of Labrador.)
6.— 0° F.	... ...	Present climate.

The interval between the first and second corresponds to the azoic rocks; that between the second and third to the palæozoic rocks; and that between the third and fourth to the neozoic rocks. Now, although we do not know the coefficient that fixes the rate of cooling of the hot earth suspended in cold space, we know the law of such cooling, and can compare, by calculation, the proportions of the foregoing intervals of time with each other.

When this calculation is made we obtain:—

Azoic time...	... (212°–122°)	33·0 per cent.
Palæozoic time ...	(122°– 68°)	41·0 „
Neozoic time ...	(68°– 48°)	26·0 „
		100·0 „

In my former note, iii. p. 545,[1] I have given a table of the approximate thicknesses of the several strata in Europe. That table was prepared, with the assistance of the late Prof. Phillips, many years ago, and is not as complete as it might be. I therefore sought the assistance of Prof. Edward Hull, Director of the Geological Survey of Ireland, and with his help I have constructed an improved table.

Converting the maximum thicknesses recorded in that table into percentages, and comparing them with the percentages of time found from the theory of a cooling globe, we find—

Scale of Geological Time.

Period.	From Theory of Cooling Globe.	From Maximum Thickness of Strata.
Azoic	33·0 per cent.	34·3 per cent.
Palæozoic	41·0 „	42·5 „
Neozoic	26·0 „	23·2 „
Total ...	100·0 „	100·0 „

The agreement between these figures, derived from entirely independent sources, is remarkable, and tends to justify the principle held by many geologists, that—

The proper relative measure of geological periods is the maximum thickness of the strata formed during those periods.

This is equivalent to supposing the rate of deposition of strata to have been constant during the period contained in the table, which is probable enough on other grounds; for, although the rock-making forces were greater when the heat was greater, it must be remembered that the land surfaces to be denuded were smaller, and that the sea bottoms, on which the *débris* was to be spread, were also greater. The calculation founded on the theory of the cooling globe cannot with safety be carried down to near the point of equilibrium temperature, which is the Fahrenheit zero (for the Arctic regions under consideration); but we may, without risk, extend the calculation from 48° F. to 32° F.; that is, we may estimate the interval of time from the miocene tertiary epoch, when the Parry Islands and Northern Greenland enjoyed a Lombardic climate, to the epoch (probably long past) when those districts suffered a climate like that of Labrador, but better than that they now have.

The result of the calculation, when reduced to the same scale as that used in the table, is 32 per cent., a result, the importance of which will be better seen by the following propositions which flow from it:—

1. *A greater interval of time now separates us from the miocene tertiary epoch than that which was occupied in producing all the secondary and tertiary strata, from the triassic to the miocene epoch.*

2. *The enormous interval of time that separates us from the miocene epoch affords ample opportunity for the development of the gigantic mammals, which are commonly supposed to have somewhat suddenly made their appearance on all our continents, and to have disappeared as suddenly.*

All the foregoing facts point to the conclusion that the present condition of the earth's surface is profoundly different from its condition in the geological periods when climates depended chiefly on the internal heat of the earth, and not on that of the sun, as at present.

The following table contains estimates of the number of years required by the several rivers to scrape off one foot from their respective rain-basins, and carry the materials to the sea, where it is spread out on the sea bottoms by ocean currents. The figures are obtained by carefully measuring, at frequent intervals, the total discharge of water and the total weight of mud held in suspension. This weight of mud, reconverted into surface rock, must cover the entire rain-basin to a depth of one foot spread uniformly.

Rates of Denudation of Rain-Basins Lowered One Foot.

Ganges	2,358 years.
Mississippi	6,000 „
Hoang Ho	1,464 „
Yangtse Kiang	2,700 „
Rhone	1,528 „
Danube	6,846 „
Po	729 „
Mean...	3,090 „

From this table it appears that atmospheric agencies are capable, at present, of lowering the land surfaces at the rate of one foot per 3,000 years; but since the sea bottoms are to the land surfaces in the proportion of 145 to 52, the rate at which (under present circumstances) the sea bottoms are silted up, that is to say, the present rate of formation of strata, *is one foot in* 8,616 *years*. If we admit (which I am by no means willing to do) that the manufacture of strata in geological times proceeded at *ten times* this rate, or at the rate of one foot for every 861·6 years, we have for the whole duration of geological time, down to the miocene tertiary epoch,

$$861{\cdot}6 \times 177{,}200 = 152{,}675{,}000 \text{ years.}^{1}$$

To this must be added at least one-third, as before shown, to bring in the period from the Miocene Tertiary to the time when the Parry Islands and North Greenland had the climate of Labrador.

This gives for the whole duration of geological time a *minimum of two hundred millions of years.*

[1] *Proc.* R. S., December 20 1877

[1] The coefficient 177,200 is the total number of feet of maximum thickness of all the known stratified rocks.

ACTION OF DRUGS ON THE LIVER[2]

PROF. RUTHERFORD'S paper described the concluding results of the long research undertaken by him on "The Biliary Secretion with Reference to the Actions of Cholagogues." He pointed out the difficulties which had rendered it impossible for physicians to arrive at precise knowledge as to the actions of substances on the liver from observations on the human subject, and the imperative necessity for having recourse to experiments on animals, whereby some of the factors that complicate the case in the uninjured system may be eliminated, and definite knowledge regarding the action of agents on one of the most important organs of the body instituted for the vague guesses of twenty centuries. Several previous investigators had striven by experiments on animals to settle this question, but all had failed owing to the faulty character of the methods employed. By a new and precise method of continuous collection of the bile, and measurement of the amount secreted every fifteen minutes—with a careful elimination of disturbing factors—the whole physiological pharmacology of the liver has been worked out by Prof. Rutherford—as far as it seems at present desirable to proceed. The actions of as many as forty-six substances on the bile-forming function of the liver have been investigated, and results of much importance for rational therapeutics obtained. Some of the

[2] Abstract of paper read at the Royal Society of Edinburgh on June 17, by Prof. Wm. Rutherford, F.R.S., Prof. Sir Wyville Thomson (in the absence of Sir Wm. Thomson) in the chair.

substances employed, viz., sodium salicylate, the benzoates, phytolaccin, physostigma, euonymin, sanguinarin, ipecacuan, &c., have not hitherto been known to stimulate the liver; and definite information has now been obtained regarding the influence of a number of other substances whose effects have been hitherto altogether doubtful. He has also proved that if a purgative agent has no direct stimulating power on the liver it diminishes the secretion of bile, and the importance of this fact is indicated. The results of the experiments which were performed on dogs are in complete harmony with every fact that has been perfectly ascertained in the human subject. The experiments with every substance supply a precision of knowledge regarding the effect of that substance on the liver which has not previously existed. In indicating the place for such experiments in medical science, Prof. Rutherford said:—"We all know how excessively complicated the analysis of the effects of drugs becomes when they are administered to a bodily system distorted in its action by the effects of disease. Of necessity the influence of a drug upon a diseased state is the ultimatum of pharmacology; and every experiment upon a healthy bodily system, whether of man or animal, is merely ancillary to experiments with the drug in disease. If we discover that a drug stimulates the healthy liver of a dog, we do not conclude that it must also stimulate the human liver in health, and still less do we conclude that it must have this action in disease. The experiments on the healthy liver of the dog, on the normal and on the abnormal human liver, are three sets of experiments, closely related, but still distinct. The results of any one of the three series cannot be substituted for those of the other two. Each set of facts has its own proper place, and must be carefully kept there. When, therefore, we show by our physiological method of experiment that such a substance as sodium salicylate or sodium benzoate powerfully stimulates the liver of a dog, we do not for a moment say to the clinical observer—You will find that these things act thus in man; but we merely say this: Experiment with these agents on man, and tell us whether or not you find that they stimulate his liver, and tell us also in what diseased states you find the employment of this or of that substance most advantageous. The clinical experimentalist has a far more difficult task to discharge than the physiological investigator, and he urgently requires all the assistance that physiological methods can render him; and the more so because it is now admitted by all competent thinkers that the actions of medicinal agents in diseased conditions cannot be rightly understood unless we also know their effects in a healthy condition of the bodily system." He further showed that although therapeutics can never be brought within the sphere of exact science, it is nevertheless very urgently our present business not to fold our hands in a despairing nihilism, but to search for every fact that can throw light on the function of every bodily organ, the nature of its diseased conditions, and the manner in which it is influenced by medicinal agents in its normal and abnormal states; and all we desire is that those who don't comprehend our methods of procedure, although they are ever ready and eager to profit by its results, will, instead of throwing obstacles in our way, leave us to do what we can to alleviate not only the sufferings of human beings, but also those of animals.

At the conclusion of the paper Sir Robert Christison characterised the professor's communication as of the greatest importance, and as one which would hand his name down to a very distant future. The professor deserved the commendation of the Society for his courage in going on, in spite of a sentimental opposition, with his researches. He thought that the time would come when the public would wake up from the delusion in this regard in which it now was. Sir Wyville Thomson, in intimating the thanks of the Society to Prof. Rutherford, said that, in his opinion, if a man in a public position felt that he had knowledge and nerve sufficient to perform these experiments for lessening the suffering and prolonging the lives of men, even though they should involve a certain amount of suffering to the lower animals, he was not only entitled but was bound to peform them.

SOCIETIES AND ACADEMIES

London

Royal Society, May 16.—"On the Spectra of Metalloids. Spectrum of Oxygen." By Arthur Schuster, Ph.D., F.R.A.S. Communicated by J. Clerk Maxwell, F.R.S., Professor of Experimental Physics in the University of Cambridge.

The many unexplained phenomena attending the passage of electricity through gases will probably for some time to come occupy the attention of experimental physicists. It is desirable that the subject should be approached from as many different sides as possible. One of our most powerful instruments of research is the spectroscope, but before it can be applied to the study in question we have to settle the chemical origin of the different spectra, which we observe in vacuum tubes, and to discuss in what way such spectra are liable to change under different circumstances. I have chosen oxygen as a first subject of investigation. Though Plücker and Wüllner have, as far as their experiments went, accurately described the phenomena seen in oxygen tubes, the following contains much that is new, and will put some of the older facts on a firmer basis.

As some of the facts brought to light by the investigation bear directly on the question of double spectra, our knowledge on that point must be briefly referred to. We divide all known spectra into three orders—continuous spectra, channelled space spectra, and line spectra. With regard to continuous spectra, it is shown that the older statement which limited them to liquid and solid bodies is no longer tenable. Most gases give continuous spectra long before they condense. Two theories of continuous spectra are noticed. The one considers that the vibrations of a molecule always tend to take place in a fixed period, but that the impacts of other molecules may, when the pressure is great or in liquid and solid bodies, prevent complete oscillations taking place, and thus produce a continuous spectrum. The other theory considers that, when a gas condenses, molecular combinations take place, which make the molecular structure more complicated, and may produce channelled space spectra or continuous spectra. According to the latter theory such molecular combinations are possible before the gas condenses, and thus the state of aggregation of the gas only indirectly affects the spectrum. The latter theory seems to be more consistent with experiment than the former one. For instance, it is shown that oxygen gives a continuous spectrum at the lowest temperature at which it is luminous. If the temperature be raised, the continuous spectrum is replaced by a line spectrum. This seems to be inexplicable by theory of molecular impacts.

The chief difficulty in the way of a complete investigation of the spectrum of oxygen consists in the great disturbing influence of the presence of even a small quantity of any carbon compound. Amongst a great many oxygen tubes which were filled by various makers I only found one, which showed the spectrum of pure oxygen; all the others gave a spectrum of carbonic oxide. It is therefore necessary in filling oxygen tubes to avoid all greased joints and all india-rubber tubings. I have used a Sprengel air-pump which communicated with the vacuum tube by means of a ball and socket joint. The joint was kept airtight solely by means of strong sulphuric acid. The vacuum tube was fused directly to the ball of the joint. To one end of the vacuum tube a piece of hard glass tubing had been fused. This was filled with different substances which, on heating, gave off pure oxygen. The oxygen, therefore, came only into contact with glass, mercury, and sulphuric acid, and the metal of the electrode. Permanganate of potash, oxide of mercury, and chlorate of potash, were used in turn, to prepare the oxygen, but no effect was observed which could be traced to the substance used. The effect of the electrodes was eliminated by varying the metals. Aluminium, platinum, silver, brass, and iridium were used as electrodes. Any possible effect of the glass was eliminated by finally repeating all experiments in a glass receiver six inches in diameter, so that no part of the spark came nearer than 2½ inches to the glass. In this way it is believed all possibility of error due to the presence of any possible impurities was avoided.

Four different spectra of oxygen must be distinguished. At the lowest temperature at which oxygen becomes luminous it gives a continuous spectrum. As the temperature is gradually raised the continuous spectrum is successively transformed into two distinct line spectra, which I call respectively the compound line spectrum and the elementary line spectrum. It is one of the principal objects of this paper to show that these two line spectra which have been much mixed up together have a separate existence. The generation of one always involves the destruction of the other. The fourth spectrum is that which is always seen in vacuum tubes at the negative pole.

The Continuous Spectrum.—The following facts prove the statement that at the lowest temperature at which oxygen is luminous it shows a continuous spectrum.

1. The wide part of a Plücker tube generally shines with a faint yellow light. When looked at by means of a prism the spectrum is perfectly continuous.

2. If a spark of an ordinary Ruhmkorff coil is taken in oxygen at atmospheric pressure, one of the line spectra generally appears, but when the break is put out of adjustment so as to weaken the spark, the lines disappear and are replaced by a continuous spectrum which has its maximum of intensity in the greenish-yellow, and gradually fades away towards both ends of the spectrum.

3. Becquerel mentions an observation according to which the point of the oxy-hydrogen flame takes a yellow colour when an excess of oxygen is present. The description of the somewhat characteristic colour which Becquerel gives coincides exactly with the colour of the spark in oxygen, when it shows the continuous spectrum. According to Plücker an excess of hydrogen shows the hydrogen lines, and it is therefore reasonable to suppose that in Becquerel's experiment the oxygen was sufficiently heated up to become luminous.

The continuous spectrum must not be confounded with the continuous spectrum, which under high pressure forms the background to the line spectrum.

The Elementary Line Spectrum.—This is the spectrum which is seen when a strong spark passes through oxygen at the atmospheric pressure. It can be seen at all pressures when a jar and air break are introduced into the circuit.

The Compound Line Spectrum.—Plücker, in his first investigation of oxygen, says it consists of four lines, one in the red, two in the green, and one in the blue. In his later drawing of the spectrum of oxygen, he gives a great number of lines of which these four form a part. Wüllner says that the four lines in question are always the first to appear in oxygen tubes. Thalèn and Angström do not give these lines; Huggins does not give them; Salet does not give them. Plücker and Wüllner are the only observers who experimented under the circumstances under which the lines appear. They come out equally well whatever way the oxygen is prepared, whatever the nature of the electrode, and I have seen them under the large glass receiver already mentioned. The following is the appearance of the spectrum of oxygen as it undergoes gradual exhaustion.

When the pressure is sufficiently diminished to allow the spark to pass, it shows a yellow colour and the spectrum is perfectly continuous. Almost immediately, however, the four lines are seen in the capillary part of the tube above the continuous spectrum. The continuous spectrum in the wide part is stronger than in the narrow part. The four lines seem to have taken away part of the energy of the continuous spectrum. As the exhaustion proceeds, the spark spreads out in the wide part, and the continuous spectrum is therefore diminished and becomes less intense than in the capillary part; but it gradually loses in intensity also in the narrow part, until the four lines stand out on a perfectly black background. If under these circumstances the jar and air break are inserted in the circuit, everything will disappear and the elementary line-spectrum will come out. We have here as complete a transformation as from the band-spectrum of nitrogen to the line-spectrum of nitrogen taking place under precisely the same circumstances; and it is therefore not unlikely that the two phenomena are due to the same cause. There are two reasons why the existence of the compound line-spectrum of oxygen as a separate spectrum may have escaped previous observers. There is a blue line in the elementary line spectrum which is nearly coincident with the blue line of the compound line spectrum. It requires considerable dispersion to notice the difference; the complete disappearance of the compound line-spectrum has therefore escaped notice. The two green lines and the red line of the compound spectrum widen easily at higher pressure and as has been remarked by Wüllner, even fuse together to a continuous spectrum. If the experiment is therefore made at a pressure at which oxygen has a continuous back-ground, the disappearance of these lines might be taken for their widening and fusing together. No such mistake is possible when the vacuum is good. I have not been able to determine with certainty whether the red line seen at atmospheric pressure is a remnant of the compound line-spectrum, or whether it is a line of the elementary line-spectrum closely coincident. I am inclined to the former view, although it often seemed as if the line seen at atmospheric pressure was less refrangible than the red line of the compound line-spectrum. I have drawn attention in a letter to NATURE (vol. xvii. p. 148), to the fact that the compound line spectrum of oxygen seems to be reversed in the sun. I have no further information to add on that point, and the wave-length of the lines will be found in that letter.

The Spectrum of the Negative Pole.—This spectrum has first been correctly described by Wüllner. It consists of five bands, one of which is too weak to be measured. Careful measurements of the bands have been taken. With regard to the explanation of the separate spectra found at the negative pole in nearly all gases, I incline to the view that they are due to separate molecular compounds which are formed at the pole. The following experiments seem to support that view. When the pressure is very small the spectrum of the negative pole extends throughout that half of the tube which incloses the negative pole, and which I shall call the negative half. If the current be suddenly reversed the spectrum of the negative pole will still be seen at first, in that part which was the negative half and now is the positive half of the tube; but it will gradually disappear and a permanent state will be established, in which the spectrum of the negative pole is, as before, only seen in the negative half. That it is the reversal and not the interruption of the current which produces the result is easily proved by interrupting the current and at once closing it again the same way, when no difference will be seen. If, however, the current be left interrupted for some time, say one minute, so that any compounds which may have been formed in the negative half may diffuse into the other half, and if then the current is closed, either the same or the opposite way, the negative spectrum will be seen at first throughout the tube, but gradually disappear in the positive half.

If the current be rapidly reversed in succession, after a little while, when the effect of the first reversal has disappeared, the permanent state will always be established at once, and the spectrum of the negative pole will appear only in the negative half.

If after the last experiment the current be interrupted for some time and then closed, the spectrum of the negative pole will at first be seen throughout the tube, and gradually disappear in the positive half.

It is not quite easy to see the explanation of the last two experiments.

The experiments were all made in the Cavendish Laboratory, Cambridge, and I am much obliged to Prof. Clerk Maxwell for the kindness with which he has placed the resources of the Laboratory at my disposal.

Linnean Society, May 24.—Annual General Meeting.—Prof. Allman, F.R.S., president, in the chair.—The anniversary address of the president dealt with a *résumé* of the principal recent discoveries in the anatomy and development of the Polyzoa, and of the resulting important features in their systematic grouping. Much had been due to the labours of Busk and Nitsche. It was maintained that investigations were mainly in favour of the so-called "brown bodies" being merely the residuum of degraded and withered polypides, and that they have no real morphological or physiological importance. He coincided with the views of Nitsche, Joliet, and Busk, that the supposed "colonial nervous system" is but an irregular plexus of cellular and protoplasmic cords and filaments derived from the walls of the zoœcium or polypide cell, and not a true nervous system. Joliet's idea of its being the origin of new polypide buds and of certain minute free corpuscles found in the zoœcium is, however, too exclusive. *Cyphonantes* is a singular little free-swimming marine creature, of pyramidal form, the soft body of which is contained within a bivalve shell. Schneider has regarded it as a larval Polyozoon, and announced the startling fact that before its transformation into the adult it becomes totally disorganised and reduced to a homogeneous protoplasmic mass, though previously its structure had been complex. Thereafter arises a new polypide, and the whole is metamorphosed into the adult form. Strange as this history may seem, it has been confirmed by the researches of Nitsche and Joliet. Finally, the question of "individuality," or the relation to the polyzoal colony was taken up by the president, and the following opinion enunciated—that the zoœcium or cell in which the polypide is lodged must be regarded as having a zooidal individuality independently of the polypide, which has a zooidal individuality of its own, and that the two thus form a compound element which becomes associated with similar ones in order to form the colony. This compound element is thus composed of two zooidal individuals—zoœcium and polypide; on the zoœcium devolving the functions of sexual and nonsexual reproduction, and on the polypide that of nutrition.—Prof. Allman

also called passing attention to some living tree frogs (*Hyla arborea*) which he had obtained in the South of Europe. Those now exhibited to the Fellows showed the remarkable change of colour which this species of frog is known to possess, some being green, others bright blue. This change of hue is due to certain pigment corpuscles the precise nature of which he at present is investigating.—The Report on Publications was read by the Secretary, and that of the balance-sheet by Dr. R. C. A. Prior. Afterwards the Treasurer (Dr. J. Gwyn Jeffreys) laid his statement of accounts, &c., for the year 1877, before the meeting. This showed a very satisfactory financial position, a balance of 46*l*. 13*s*. remaining in hand, after all current expenses had been paid, while 700*l*. had been invested since the last Annual Report. The alterations in the bye-laws relative to an increase in the rate of payment for Fellows compounding, previously read at two successive general meetings, was put to the ballot and confirmed by the Fellows at large in the terms of the Charter.—The Secretary gave a notice of the Fellows and Foreign Members who had died during the past twelvemonth; of the former there were ten, and of the latter four, viz., fourteen in all. Among these Mr. Henry Adams, Dr. Elias M. Fries, Mr. Andrew Murray, Prof. Parlatore, Mr. Fox Talbot, Dr. R. Visiani, Dr. H. A. Weddell, and Mr. T. V. Wollaston, deserve mention as of considerable repute in the scientific world. During the year thirty-eight Ordinary Fellows and five Foreign Members had been elected.—At this meeting also the following Fellows were elected into the Council:—Mr. J. Ball, Dr. T. Boycott, Mr. F. Du Cane Godman, Dr. A. Günther, and the Rev. G. Henslow, in the place of Mr. J. G. Baker, Dr. W. B. Carpenter, Mr. Henry Lee, Prof. W. K. Parker, and Mr. S. I. A. Salter, who retired by rotation. The President and Officers were re-elected.

Physical Society, May 25.—The President, Prof. W. G. Adams, in the chair.—The following candidates were elected Members of the Society:—W. Kieser, T. McEniry, W. R. Philips, G. M. Whipple.—Mr. D. J. Blaikley read a paper on brass wind instruments as resonators, describing an attempt he has made to carry into some detail certain acoustical investigations of the late Sir C. Wheatstone. A method by which the positions of the notal points in a cone and in a bugle had been fixed was shown, and it was then shown that a complete cone cannot be used by the lips as a wind instrument, that conic frustra cannot give resonance to the same series of notes as complete cones, and that therefore the conical form must be modified; and, as this modification of form makes the position of a node for every note required more or less coincide with that of the lips, so will the instrument be more or less perfectly in tune. As the number of quarter wave-lengths in a cone or wind instrument is not directly proportional to the vibrational number of the note, as it is in free space or in an open tube, so the velocity of the wave of a given note is not exactly the same as that of another note of different pitch. Experiments were shown to illustrate the effect of varieties of form in producing different qualities of tone, and evidence was given of the existence of very high harmonic or partial tones in the low notes of wind instruments. In the trombone the ninth partial tone (three octaves and a tone above its prime) was thus proved to be sounding, and partial tones up to the sixteenth have been heard.—Sir W. Thomson pointed out the connection between the range of a musical instrument and the phenomena observed in a trumpet-shaped bay between high and low water; he also considered that an investigation of the overtones due to the cavity of the mouth would well repay research in explaining the influence its shape has on the vowel sounds.—Lord Rayleigh observed that in a conical musical instrument, the correction to be made on account of the cone not being perfect to the apex is equal to six-tenths of the radius of the open end, and he pointed out that with a bell-mouthed instrument much of the sound is diffused as spherical waves.—Dr. Guthrie placed on the table a communication on salt solutions and attached water and on the separation of water from crystalline solids in currents of dry air, in continuation of his researches, which have already been published. The results could not be usefully abstracted, but as an instance of the important results obtained it may be mentioned that Dr. Guthrie finds that when dry air is passed over chloride of barium at a temperature just above 25° C., the β molecule of water is given off, and that the α molecule of water is only separated at a temperature just above 60° C. He also showed the effect of a steam jet in boring through a block, mainly with a view of obtaining suggestions as to the use of such a method in the commercial preparation of ice.—Mr. Rutherfurd then showed a photograph of the solar spectrum from the line E to H, taken by means of a grating. By means of a heliostat he concentrated the rays on a lens within a collimator, which in relation to the observing telescope was of considerable length, in order to admit as much light as possible, and the grating was movable. The enlargement was effected by inserting a lens near the focal point of the observing telescope, and he used a sensitive collodion which gave the greatest sharpness of definition about the line G.—Sir W. Thomson, in continuation of the communication made to the Society at its last meeting, described the effect of torsion on the electric conductivity of a tube of brass. We have already given an account of this paper.

Anthropological Institute, May 28.—Major-Gen. A. Lane Fox, F.R.S., vice-president, in the chair.—Mr. Hyde Clarke exhibited a carved stone object which was considered as having come from Central America.—Col. Paske read a paper on Buddhism in Little Tibet. After a brief description of the route through the Kangra and Kulu Valleys to the high mountain passes leading into Lahore and Spiti, he gave particulars of the physical features of these countries, their products, &c., with some account of the habits and customs of the people, concluding with observations on Buddhism. Col. Paske gave an explanation of the modified form of Buddhism prevalent in the provinces of Little Tibet, and brought to notice the ritual and religious customs of the Lamas or Buddhist priests; described his visits to Buddhist monasteries, exhibiting specimens of Buddhist ritualistic instruments, and other curiosities, with a small painting representing the "Triumph of Buddhism," executed by a Lama recently arrived from Llassa.—Mr. Brabrook read a paper by Mr. Alfred Simson, entitled Notes on the Piojés of the Putumayo. A tribe of Indians occupying the middle and lower Aguarico and a considerable stretch of the left bank of the Napo are known as the Santa Maria Indians or Piojés, from the word in their language, piojé, and speak the same language, and have several traits in common with the Indians inhabiting the borders of the Upper Putumayo, who seem to have no special appellation, but which Mr. Simson proposed to call the Macaguajes or Piojés of the Putumayo. Mr. Simson's experience of these Indians extended only to those living on the banks of the main stream, during long journeys with a number of them selected from different villages, and visits and sojourns in most of these villages. Their dwellings, religion, and customs were freely described. Mr. Simson also communicated a vocabulary of the Zaparo language.

Geological Society, June 5.—John Evans, F.R.S., vice-president, in the chair.—William Santo Crimp and Joseph Richard Haines were elected Fellows of the Society.—The following communications were read:—On the quartzites of Shropshire, by Charles Callaway, F.G.S.—On the affinities of the Mosasauridæ, Gervais, as exemplified in the bony structure of the fore fin, by Prof. Owen, C.B., F.R.S.—On new species of *Procolophon* from the Cape Colony, preserved in Dr. Grierson's museum, Thornhill, Dumfriesshire; with some remarks on the affinities of the genus, by Harry Govier Seeley, F.L.S., Professor of Geography in King's College, London.—On the microscopic structure of the Stromatoporidæ, and on palæozoic fossils mineralised with silicates, in illustration of eozoon, by Principal Dawson, F.R.S.—On some Devonian Stromatoporidæ, by A. Champernowne, F.G.S.—On a new species of *Loftusia* from British Columbia, by George M. Dawson, F.G.S., of the Geological Survey of Canada.

Chemical Society, June 6.—Dr. Gladstone, president, in the chair.—The following papers were read:—Analogies between the action of the copper-zinc couple and occluded and nascent hydrogen, by Dr. Gladstone and Mr. Tribe. The authors have observed that finely-divided copper charged with hydrogen converts nitre into potassium nitrite and ammonia, and reduces potassium chlorate to chloride. The copper-zinc couple converts nitrobenzol in aqueous solution into anilin, a reaction which the authors have utilised for the detection of small quantities of nitrobenzol. The action of palladium-hydrogen, platinum-hydrogen, and carbon-hydrogen on various substances have been investigated, and compared with the action of the copper-zinc couple. During the reading of the paper, Dr. Russell took the chair.—On the alkaloids of the aconites, Part 3, by Dr. Wright and A. P. Luff. The authors have continued their researches on these alkaloids, and in the present paper investigate the saponification, &c., of aconitin, picraconitin, and have obtained two new bases, aconine and picraconin; acetyl and ben

zoyl derivatives of several of the bases have been formed. The authors draw an important practical conclusion from their work, that it is quite possible to obtain crystallised alkaloids of constant composition from *A. ferox* and *A. napellu*, instead of the amorphous preparations which are now sold, and which often contain forty or even ninety per cent. of bases more or less inert.—On the alkaloids of the Veratrums; Part 1, Alkaloids of *Veratrum sabadilla*, by Dr. Wright and Mr. Luff. After discussing the conflicting statements which have been made by previous observers, the authors give details of the process of extraction, which consisted in percolating the crushed seeds with alcoholic tartaric acid, evaporation and extraction by numerous and prolonged shakings with ether. Three alkaloids were obtained: veratrine, $C_{37}H_{53}NO_{11}$, which, on saponification, splits up into veratric acid, and a new base, verin; cevadin, $C_{32}H_{49}NO_9$, splitting up, on saponification, into cevadic acid (methylcrotonic acid) and cevin; cevadillin, $C_{34}H_{53}NO_8$, which does not crystallise or form crystalline salts.—On the action of hydrochloric acid upon chemical compounds, by J. W. Thomas. The author has examined the action in several ways of hydrochloric acid on many salts, nitrates, sulphates, tartrates, citrates, chromates, oxalates, &c.—On the action of oxides on salts, Part 1, by Dr. Mills and Mr. Wilson. The object of the authors was to determine the law in consequence of which the action of oxides on salts leads in general to the formation of other oxides derived from the salts in question. They have studied the action of tungstic, silicic, and titanic oxides on potassic carbonate at a high temperature. —On a new test for glycerin, by Dr. Senier and Mr. Lowe. This test is founded on an observation of Iles, that borax, when treated with glycerin, gives to a Bunsen flame the green colour characteristic of boracic acid. By means of the test, one-tenth per cent. of glycerin, was detected in beer after concentration, &c.—On ammonium triiodide, by G. S. Johnson. The author has prepared this substance by dissolving iodine to saturation in a strong aqueous solution of ammonium iodide, and by stirring crystals of ammonium iodide and iodine with a small quantity of water, till the resulting black liquid refused to dissolve more of either ingredient. The liquid, on evaporation over sulphuric acid, gave dark blue prisms of the substance in question slightly deliquescent; specific gravity, 3·749.

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Academy of Sciences, June 24.—M. Fizeau in the chair.—The following among other papers were read:—On the displacement of the bubble in spirit-levels, by M. Plantamour. Movements were observed (both from day to day and in the course of single days) in levels placed on the massive table of the author's limnograph, at Geneva, on the beton covered ground beside it, on the ground in a tent, and also in the author's cellar, some distance from the lake. In certain periods there is a gradual rising in the east without notable return to the west; in others there is a certain horizontal immobility, and in others, lastly, of longer or shorter time, the ground undergoes oscillations both from east to west and from north to south, more or less pronounced and regular, the limits being, however, always narrow (the greatest movements did not reach twenty seconds). M. Plantamour does not at present try to explain these movements; (they are indicated graphically).—M. D'Abbadie recalled similar observations he had formerly made, and thought this phenomenon might be an important source of error in astronomical calculations (*e.g.*, in determining latitudes and the declination of stars).—M. de Lesseps presented a stone from Chalouf, 10m. above the sea, believed to belong to the tertiary epoch, and having incrusted on it a large shark's tooth, three times the size of teeth of sharks now caught in the Red Sea, and probably belonging to a species now gone.—The death of M. Ehrman, correspondent at Strasburg, was announced.—Results of application of sulphocarbonate of potassium to phylloxerised vines, by M. De la Vergne. He considers it indispensable for very young plants with small root system, and for all vines grown in a very thin layer of mould.—On the depolarisation of electrodes by solutions, by M. Lippmann. The property of depolarising a metal belongs exclusively to salts of that metal. Hence a method of detecting the presence of a particular metal in a solution. Thus, for copper; put a copper wire as negative electrode of a weak current in the liquid; it will be polarised if there is no copper dissolved in the latter, and it will not be polarised if the liquid contain $\frac{1}{5000}$ of sulphate of copper. For silver the sensibility seems to be greater.—On a new dielectric constant, by M. Neyreneuf. In comparing different dielectrics in a condenser, he finds that for glass of the same nature the ratio $\frac{e}{n}$, of the thickness to the number of sparks corresponding to a given quantity of electricity, is constant. For more insulating substances, as ebonite, caoutchouc, &c., this ratio or *condensing constant* increases considerably with the thickness; the condensing constant of air is much greater. There is no similarity between the condensing constant and the ordinary dielectric constant.—On an experiment in magnetism relative to the telephone, by M. Luvini. He filled a hollow electromagnet with water which he inclosed, a capillary tube being connected to show any variations in the capacity; but no such variations appeared with any kind of current. (The arrangement would have indicated a change of volume of $\frac{1}{50}$ cub. mm.) He infers that the changes caused by magnetising action in a magnetic mass are wholly molecular. The sounds in resonant electro-magnetic rods discovered by Page are due to reactions of the two magnetic movements, and the current.—On the telepone, by M. Des Portes. This relates to experiments on board the *Desaix;* a telephone being at one end of the circuit and a telephone magnet, with coil uppermost, suspended vertically by silk thread. The latter magnet was struck with various substances, wood, soft iron, &c., and the sounds were heard. Peculiar effects were got on striking with a magnet or speaking. M. du Moncel added an account of similar experiments.—On electro-magnets, by M. Bisson. He winds in a new way: after each row he brings the wire in a straight line to the starting-point and recommences. He thus obtains a third more power.—On the efficacy of a vibratory movement for causing decomposition of explosive liquids and ebullition of superheated liquids, by M. Gernez. He rubs the tubes with a wet cloth, producing vibration and sound.—On organic dust in suspension in the air, by M. Miquel. The average number of microbes of the air, small in winter, increases rapidly in spring, remains nearly stationary in summer, and diminishes in autumn. Rain always causes their recrudescence. —On the pressure of the cephalo-rachidian liquid, by M. Bochefontaine.

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ERRATA.—Vol. xviii. p. 215, 1st col., 33rd line from bottom, for "sea" read "Lea." P. 216, 2nd col., 15th line from top, for "489 mm" read "4 mm. square."